MEADE'S

MANUAL FOR STUDENTS.

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MEADE'S

MANUAL FOR STUDENTS

PREPARING FOR MEDICAL EXAMINATION.

FIFTH EDITION, ENTIRELY REWRITTEN.

BY

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PREFACE.

WHILST the process of acquiring a knowledge of the science and art of Medicine and Surgery is confined to the brief period it now occupies, Manuals, such as this, will ever be popular. It matters not whether it be in preparing for examinations, or in the bustle of practice, it is essential to have a book by one which will clearly, and at a glance, set forth some lapsing technical point. Examiners blame teachers for producing such works, and teachers, in turn, denounce the system of examinations that requires so much cramming. Until a change is made in the duration of the course of study at a medical school, in English schools now practically limited to two and a-half years, there is no hope of expunging productions such as this from the student's and the practitioner's libraries.

The idea of the original "Meade's Manual" is preserved in this edition, but the substance of the work has been completely altered to meet modern requirements. The authors have been able to produce the

manual in its present form, from considerable experience of the wants of students and young practitioners.

The authors beg to thank Mr. Henry Hoole, M.B. Lond., for his assistance in correcting proofs.

Figure 7 is copied from "Quain's Anatomy."

JAMES CANTLIE.

DANIEL COLQUHOUN.

February 14th, 1883.

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CORRIGENDA.

For "fasiculus teretes" in page 10 *read* "fasciculus teres."
,, "abduceus" in page 14 ,, "abducens."
,, "subscapula" in page 25 ,, "subscapular."

N.B.—Note that after page 139 the heading on the left-hand page ought to be "*Chemistry and Materia Medica of Inorganic Substances.*"

PART I.

ANATOMY.

THE anatomy detailed in this concise enumeration of facts is only of the most meagre kind; the enumeration even is incomplete, and the attempt at description almost *nil*. Hence, let no student imagine that by reading these pages he is reading anatomy. He is only running over useful points in clinical medicine and surgery with which he ought to have been once as familiar as the spelling of his own name. The main outlines of anatomy one never forgets: such as the course of the main vessels; the position of the stomach, liver, &c.; the regions of hernia; and the parts of the urethra. But when a surgical operation is about to be undertaken, when a difficult point in abdominal diagnosis arises, or when the exact lesion in a case of paralysis of cranial or spinal nerves, or of both, has to be made out, there are few of us that would not be thankful to refresh our memories in regard to the anatomy of the part; and it is with this notion in view that anatomy has been introduced in the re-editing of "Meade's Manual." The days in which such knowledge was sufficient for examinations on anatomy have happily gone by; but more than ever is it necessary not to disgust any one working at clinical medicine or surgery with the modern amount of descriptive anatomy, when searching for any one fact or group of facts. Having stated this much, it is unnecessary to add more to warn any one against reading this imperfect compendium with the idea of learning anything more of anatomy than that which is clinically useful. It is impossible to tack on even meagre details of physiology, and so it has been wholly *left out* in this edition.

The following are some of the statistics daily required in regard to the composition of some of the fluids and solids of the body:—

Table I.

a. Blood. Reaction, alkaline. Sp. gr. 1055.

Solids	21
Water	79
	100

b. Blood serum. Sp. gr. 1025.

Albumen	8
Fats, salts, &c.	2
Water	90
	100

c. Red corpuscles. Size, $\frac{1}{3200}$ of an inch in diameter.

Solids	44
Water	56
	100

90 per cent. of the solids consists of hæmoglobin.

Fibrin is present to the extent of 0·25 per cent. in blood.

Table II.

Bone.

Animal matter	33
Mineral matter, bone salts	67
	100

Bone Salts.

Phosphate of lime	51
Carbonate of lime	11
Fluoride of calcium, magnesia, and soda	5
	67

Table III.

Bile, alkaline reaction.

Solids	14
Water	86
	100

The solids are :—

Glyco- and taurocholate of soda	9·0
Fats	1·0
Cholesterin	0·2
Mucus and pigment	3·0
Inorganic salts	0·8
	14

A body weighing 11 stone—*i.e.*, 154 lbs.—is made up of (*see* Huxley's Physiology) :—

Muscles	68 lbs.
Fat	28 ,,
Skeleton	24 ,,
Abdominal viscera	11 ,,
Skin	10½ ,,
Brain	3 ,,
Thoracic viscera	2½ ,,
Blood (lost at death)	7 ,,
	154

Analysis of Urine is given under Diseases of the Kidney.

Owing to the general distribution of the sympathetic system of nerves, it is thought better to describe it before entering upon the more purely regional parts of anatomy.

THE SYMPATHETIC SYSTEM

of nerves consist of ganglia, plexuses, and nerves.

A. The SYMPATHETIC GANGLIA are found in pairs on either side of the middle line, in contact with the vertebral column all the way from the base of the skull to the coccyx. They are named according to the regions in which they lie, cervical, dorsal, lumbar, and sacral. Each spinal nerve is considered to have a corresponding sympathetic ganglion.

I. The CERVICAL ganglia exist as three pairs.

1. The *superior* ganglia, about 1 inch in length, lie behind the internal carotid arteries and in front of the second and third cervical vertebræ. The *branches* pass :—*upwards*, to form the carotid and cavernous plexuses at the base of the cranium; *downwards*, to the middle ganglia; *outwards*, to the first four cervical nerves; *inwards*, to form the superior cardiac nerve.

2. The middle ganglia, much the smallest, lie on either inferior thyroid artery. The *branches* pass :—*upwards*, and *downwards*, to the superior and inferior ganglia respectively; *outwards*, to the 5th and 6th cervical nerves; *inwards*, to form the middle cardiac nerves.

3. The inferior ganglia lie on the neck of the first rib. The branches pass :—*upwards*, to the middle ganglia; *downwards*, to the first dorsal; *outwards*, to the 7th and 8th cervical; *inwards*, to form the lower cardiac nerve.

II. The dorsal ganglia consist of twelve pairs, lying on the heads of the ribs on either side. A dorsal ganglion sends :—two branches *up*, to join the ganglia above; two branches *down*, to join the ganglia below; two branches *outwards*, to join the intercostal nerves; branches *inwards*, to the viscera and plexuses.

III. The *lumbar ganglia*, usually four pairs, lie on the vertebral column on either side of the abdominal aorta. The branches resemble those of the dorsal ganglia.

IV. The *sacral ganglia* consist of five pairs lying in front of the sacrum. They resemble the dorsal and lumbar ganglia in their connections. The two gangliated cords form below the *ganglia impar* in front of the coccyx.

B. The PLEXUSES are chiefly the thoracic and abdominal.

I. The thoracic plexuses are as follows :—

1. The *cardiac plexuses* :—*a*, the *superficial* cardiac plexus lies in the hollow of the arch of the aorta. It is *joined* by the superior cardiac nerve from the left upper cervical ganglion, and by branches from the vagus. It is *distributed* with the left coronary artery of the heart. *b*, the *deep* cardiac plexus lies between the right pulmonary artery and the right bronchus. It is *joined* by the cardiac branches from all the cervical ganglia except the left upper, and by branches of the pneumogastric. It is *distributed* with the right coronary artery of the heart.

2. The *pulmonary plexuses* lie one in front and the other behind the root of either lung. They are formed by branches of the vagus and upper dorsal ganglia. The branches of the plexuses enter the lungs.

II. The abdominal plexuses.

1. The *solar plexus* is a huge mass of nerve tissue on either side of the cœliac axis. It has imbedded in its meshes the *semilunar ganglia*, and receives the great splanchnic nerves. From this plexus is given off branches to form the gastric, hepatic, splenic, and renal plexuses.

2. The *hypogastric plexus* is found between the two

common iliac arteries; continued forwards from it on either side are the two—

3. *Pelvic plexuses.* These supply the pelvic viscera.

C. Sympathetic NERVES supply the blood-vessels throughout the body, but there are a few special nerves:—

1. The nervi molles surround the carotid branches.
2. The cardiac nerves, previously described.
3. The splanchnic nerves. *a*, the great splanchnics are formed by the inner branches of the lower six or more dorsal ganglia; they pierce the diaphragm and join the semilunar ganglia. *b*, the lesser, and *c*, the least, splanchnics from the eleventh and twelfth dorsal ganglia, pass through the diaphragm to join the cœliac and renal plexuses.

THE HEAD AND NECK.

The Head is divided into cranium and face.

The CRANIUM will be first considered, its coverings mentioned, and the anatomy of the brain discussed in detail. The vault of the cranium is covered by the *scalp*. The *layers* of the scalp are—1, skin; 2, superficial fascia, tightly adherent to the skin; 3, the vascular and nervous layer; 4, the occipito-frontalis muscle; 5, loose areolar tissue; 6, pericranium, or periosteum.

The *arteries* of the scalp, from before backwards, are—1, frontal, 2, supra-orbital, these come from the ophthalmic artery; 3, temporal, dividing at the highest point of the ear into anterior and posterior; 4, posterior auricular; 5, occipital. The last three come from the external carotid. Their names indicate their position.

The *nerves*, in order, from before backwards, are—1, supra-trochlear, and supra-orbital, from the first division of the fifth; 2, temporal branches of the temporo-malar nerve, from second division of fifth; 3, auriculo-temporal, from the third division of the fifth, these nerves supply all in front of the ear with sensation; 4, the facial sends temporal branches upwards, to supply motion to all the muscles of the forehead; 5, the posterior auricular, also from the facial; 6, the small occipital, from the superficial cervical plexus; 7, the great occipital, from the second cervical with a branch from the third.

The vault of the fœtal head and the head of the child, present *fontanelles.* The *posterior*, between occipital and parietal bones, is triangular in form,

and shuts shortly after birth. The *anterior*, between the frontal and parietal bones, is quadrangular in form, and remains open for some time after birth, even to the third year. The *lateral* fontanelles are two in number, placed at the posterior inferior angles of the parietal bones, and, though not large, may remain open for some short time after birth.

The cranium presents two layers of bones with diploë between. The external table derives its blood supply from the vessels of the scalp; the internal from the meningeal arteries. The veins of the diploë communicate with veins outside and inside; and some named veins pass through the mastoid and posterior condyloid foramina, and the parietal bones, communicating directly from the inner to the outer table of the skull.

On removing the bony vault of the cranium the dura mater, and the middle meningeal arteries grooving the inner aspects of the parietal bones, are to be seen. To find the artery from the surface for trephining purposes, take two finger breadths above the zygoma, and a like distance from the external angular process of the frontal bone, and the vessel will be found grooving the parietal bone.

The *dura mater* of the brain consists of an endosteal layer, a fibrous layer or dura mater proper, and a serous layer. It has named processes, the falx cerebri, falx cerebelli, and tentorium cerebelli. The first named separates the hemispheres, and serves to prevent, on reclining the head, one hemisphere pressing on the other.

In intimate relation with the dura mater are the *Pacchionian* bodies. They are found at the vault; they grow originally from the arachnoid, push their way outwards and scoop out the bone; they increase in number as age advances.

Formed in connection with the dura mater are the *cranial sinuses*. They run between the layers of the dura mater; they are lined internally by serous membrane-like veins. The sinuses are divided into three sets.

I. The posterior sets are those connected with the *torcular Herophilii*, or depression on inner aspect of the occipital protuberance. The sinuses leading towards it are the *superior longitudinal;* the *straight*, made up of the *inferior longitudinal* and the *veins of Galen;* and the *two occipital*. The blood is carried away by the *lateral* sinuses, which leave the skull through the jugular foramina to become the internal jugular veins.

II. The anterior sets are those connected with the *cavernous sinuses.* They are—the *ophthalmic* veins, joining in front, the *circular* sinus surrounding the pituitary body, and the *transverse* or *basilar sinus.*

III. The *connecting sets* are the *superior* and *inferior petrosal* sinuses. They both come from the back part of the cavernous sinuses, and join the lateral.

Beneath the dura mater is the *subdural space,* limited internally by the *arachnoid.* The arachnoid is the serous membrane of the brain; it consists of a single layer of membrane dividing the space between the dura mater and pia mater into two—one space superficial—the subdural; the other deep—the sub-arachnoid. This membrane passes from one convolution to the other without dipping in between; it allows for brain movements. Beneath the arachnoid is the sub-arachnoid space, and then the pia mater and brain.

The *pia mater* is the vascular membrane of the brain, dipping into its sulci and entering its fissures.

On removing a brain, as at a *post-mortem* examination, the following structures would be cut through in order from before backwards. After removal of the vault of the cranium, cut through the dura mater on either side, separate the falx cerebri from the crista galli, and raise it from between the hemispheres. The fingers of the left hand are now to be inserted underneath the frontal lobes, and the brain raised from out of the anterior fossa. The optic nerves will now be seen entering the optic foramina, and when cut through, the trunk of the internal carotid arteries are exposed and divided. The third nerves, as they enter the roof of the cavernous sinuses, are now pulled upon and cut through. The infundibulum is seen running down to the pituitary body, which has to be raised from out the sella Turcica. The fourth nerves enter the apex of the tentorium cerebelli, and are there cut through. The knife is now run backwards through the tentorium cerebelli on either side, and the following nerves are exposed and divided—the sixth nerves, seemingly entering the basilar portion of the occiput; the fifth nerves, as they leave the brain and pass beneath the tentorium and over the apex of the petrous portion of the temporal bones; the seventh, as they enter the internal auditory meatuses; the eighth, leaving the cranium through the jugular foramina; and the ninth, as they run towards the anterior condyloid foramina. The knife is now pushed well down

the spinal canal through the foramen magnum, and the spinal cord cut as low down as possible. When the cord is cut through, the trunk and branches of the vertebral arteries and the spinal accessory nerves are to be divided on either side. The brain is now turned out by passing two fingers through the foramen magnum and everting the cerebellum from its fossa.

At the base of the brain the blood-vessels first catch the eye. The vessels supplying the brain are the *internal carotid* and the *vertebral.* The former enters the cavity of the cranium through the carotid canal in the temporal bone, winds along the cavernous groove, and, forming a curve like the letter S, mounts up to end at the base of the brain at the anterior perforated spots. The latter enters the cranium between the occiput and atlas, and passing up the side of the medulla, finally joins in front to form the basilar. The internal carotid and basilar now give off branches that unite in an anastomosing circle, the *circle of Willis.* This is bounded in front by the anterior communicating and anterior cerebral; laterally, by the trunk of the internal carotid and the posterior communicating; and posteriorly, by the posterior cerebral and the bifurcation of the basilar.

The *anterior* cerebrals disappear in the longitudinal fissure, and supply, for the most part, the internal aspects of the hemispheres.

The *middle* cerebrals run outward in the fissure of Sylvius, embrace the island of Reil, and appearing on the outer aspect of the cerebrum, supply the greater part of it.

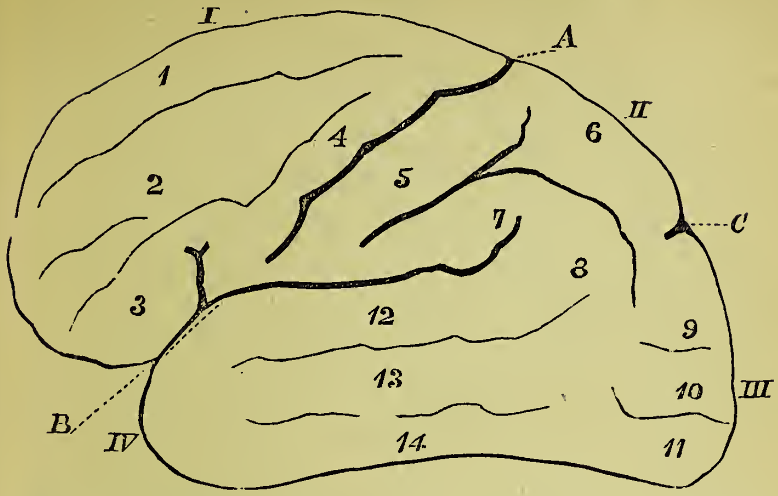
The *posterior* cerebrals are confined almost wholly to the under surface of the temporo-sphenoidal and occipital lobes.

THE BRAIN.

A short sketch of the principal parts of the brain seen on dissection will be given here. The cerebrum and cerebellum are both meted out by sulci and fissures into convolutions and lobes. The cerebral convolutions are clinically the more important.

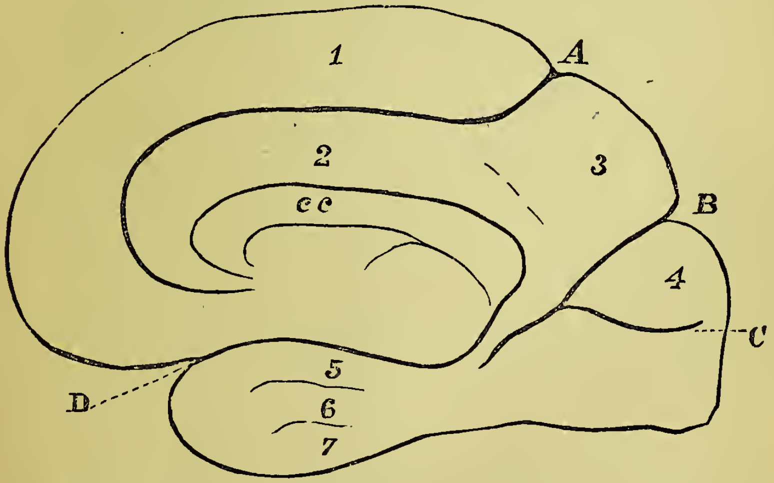
The cerebral *hemispheres* are separated by the *longitudinal* fissure, and each hemisphere is divided into five *lobes :* the *frontal, parietal, occipital, temporo-sphenoidal,* and *island of Reil.* The *fissures* dividing the lobes one from the other are: 1. The fissure of *Sylvius* running from the under to the outer surface of the brain, has the

Fig. 1.—Outer Surface of Cerebrum.



Fissures: *A*, fissure of Rolando; *B*, Sylvian fissure; *C*, parieto-occipital. *Lobes;* I., frontal; II., parietal; III., occipital; IV., temporo-sphenoidal. *Convolutions*—I.: 1, superior; 2, middle; 3, inferior frontal; 4, ascending frontal. II.: 5, ascending parietal; 6, superior parietal lobule; 7 and 8, inferior parietal lobule (supramarginal and angular gyri). III.: 9, 10, and 11, superior, middle, and inferior occipital convolutions. IV.: 12, 13, 14, superior, middle, and inferior temporo-sphenoidal convolutions.

Fig. 2.—Inner Surface of Cerebrum.



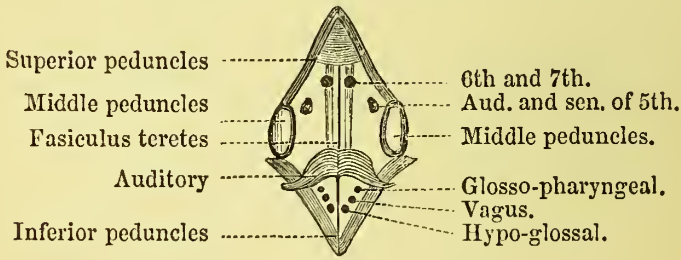
c c, corpus callosum; 1, marginal convolution; 2, callosal convolution, the gyrus fornicatus; 3, quadrate lobule; 4, cuneate lobule; 5, 6, and 7, superior, middle, and inferior occipito-temporal lobes; *A*, calloso-marginal fissure; *B*, parieto-occipital fissure; *C*, calcarine fissure; *D*, Sylvian fissure.

frontal and parietal lobes above and the temporo-sphenoidal lobes below. It embraces a group of convolutions on its way—the island of Reil. 2. The fissure of *Rolando* separates the frontal from the parietal lobe, running from near the fissure of Sylvius below to near the longitudinal fissure above. 3. The *parieto-occipital* fissure is best seen on the inner aspect of the hemisphere, and separates the parietal from the occipital lobe. 4. The *calloso-marginal* fissure is also seen on the inner surface. 5. The *calcarine* fissure is found on the inner aspect of the occipital lobe (*see* Figs. 1 and 2).

The VENTRICLES of the brain are five in number.

The LATERAL VENTRICLES (1st and 2nd) are exposed by removing the brain substance layer after layer, until the ventricles are reached. The arrangement of the brain tissue will be seen during the operation to consist of a layer of grey matter on the surface and white within.

FIG. 3.—DIAGRAM OF FOURTH VENTRICLE.



The lateral ventricles are exactly alike.

The boundaries are :—The *roof* is formed by the corpus callosum; the *floor* is formed from before backwards by the corpus striatum, tænia semicircularis, optic thalamus, choroid plexus, fornix, eminentia collateralis, and hippocampus minor. The *inner wall* is formed by the septum lucidum, which serves as a partition between the two ventricles, and between the two layers of which is the FIFTH VENTRICLE.

The lateral ventricles have three *coruna*—an anterior, posterior, and a descending. The anterior passes forwards and outwards; the posterior, backwards and inwards; and the descending, backwards, outwards, downwards, forwards, and inwards, curling round the optic thalamus. Each descending cornu presents on its floor the hippocampus major, the tænia hippocampi, the choroid

plexus, and the fascia dentata. The roof is formed by the optic thalamus. Into the apex come the choroidal vessels, to enter the choroid plexus.

On removing the corpus callosum, the septum lucidum will be found connected with its under surface. The *fornix* will now be seen as two white tape little bands, which approximate each other closely in the middle to form the body, and diverge in front and behind. In front they constitute the anterior pillars, and behind the posterior pillars of the fornix. The anterior form the corpora albicantia, and the posterior pass down behind to form the tænia hippocampi. On raising the fornix, the *velum interpositum* is seen. It consists of a reflexion of the pia mater, contains in its substance the veins of Galen going back to join the straight sinus, and has at its sides the choroid plexuses—vascular fringes from which the ventricular fluid is secreted.

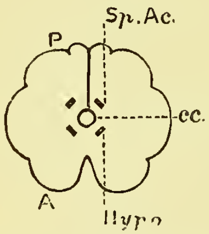
The Third Ventricle is exposed on raising the velum interpositum. The *roof* is formed by the velum interpositum; the *floor*, by the structures in the interpeduncular space—viz., the lamina cinerea, the tuber cinereum, the corpora albicantia, and the posterior perforated space. The *sides* are formed by the optic thalami. In the ventricles are seen the anterior, middle, and posterior *commissures*. The *anterior* passes through the corpus striatum, and the *posterior* through the optic thalamus, to join the brain tissue beyond; the *middle* commissure unites only the grey matter lining the optic thalami. The third ventricle *communicates* in front with the lateral ventricles through the foramina of Munro, and behind through the aqueduct of Sylvius, or iter e tertio ad quartum ventriculum, with the fourth ventricle. The aqueduct of Sylvius has above the corpora quadrigemina and below the crura cerebri. Through these various foramina processes of the choroid plexus pass from ventricle to ventricle.

The Fourth Ventricle is bounded *below and in front* by the back parts of the pons and medulla oblongata, *above* by the cerebellum, and *behind* by a reflexion of arachnoid passing from the cerebellum to the medulla.

The *sides* are formed by *peduncles*, named from their position, superior, middle, and inferior, or from the parts they run between, processus e cerebello ad testes, processes ad pontem—*i.e.*, the pons Varolii itself, and the processus e cerebello ad medullam.

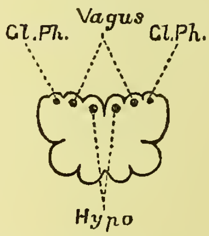
These names explain themselves. The result is a diamond-shaped space, with important functions and relations, inasmuch as most of the cerebral nerves proceed therefrom. The *roof* is formed by the valve of Vieussens and inferior vermiform process of cerebellum. The valve of Vieussens stretches between the superior peduncles; the inferior surface of the vermiform process shows from before backwards the nodule, uvula, and pyramid. The *floor* of the ventricle shows a groove or furrow in its centre, continuous below, with the central canal of spinal cord, and above with the aqueduct of Sylvius. On either side exists a ridge, the *fasciculus teretes*, and again externally to that and on either side, from above downwards, are to be seen the *locus cœruleus*, the *fovea anterior*, the *transverse striœ of the auditory nerve*, and *the fovea posterior*. Towards the lower end are

Fig. 4.



A, anterior; P, posterior part of medulla; Sp.Ac., spinal accessory nuclei; Hypo., hypoglossal nuclei; *cc*, central canal.

Fig. 5.



Hypo., hypoglossal nuclei; vagal, or pneumogastric nuclei; Gl. Ph., glosso-pharyngeal nuclei occupying the floor of the fourth ventricle.

to be seen small round elevations, which, as they correspond to nuclei of origin of cranial nerves, have to be considered more closely. To the floor of the fourth ventricle, six out of the nine cranial nerves are traced to their nuclear origin. The nuclei of some cause slight elevations on the floor, and it is these that chiefly are of importance. The most ready idea of their position is to be gained by taking sections at different heights.

A. Take a section through the medulla oblongata, just *below* the apex of the fourth ventricle and we find this appearance (*see* Fig. 4).

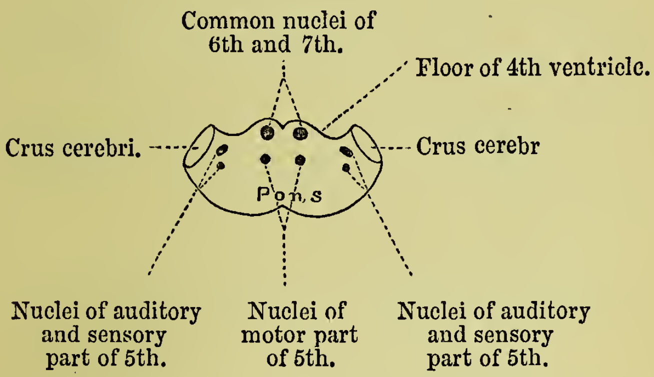
B. Take another section through the medulla, just *above* the lower end of the fourth ventricle—*i.e.*, through

the apex of the *calamus scriptorius*—and the parts will be seen as in Fig. 5.

The vagal nucleus is higher up than, and external to, the hypoglossal, and the glosso-pharyngeal is again higher up and external to the vagal nucleus (*see* Fig. 3).

C. Take a third section still higher up, the pons Varolii will be cut through and the structures seen as in Fig. 6. It will be seen that there is an internal motor and an external sensory streak in the floor of this ventricle. The motor streak, close to the central furrow, gives origin below to the hypoglossal and spinal accessory nerves, and higher up to the facial, the sixth, and motor part of fifth. The sensory streak, external to this, gives origin below

Fig. 6.



The bulge on either side of the central groove corresponds to the fasciculus teretes.

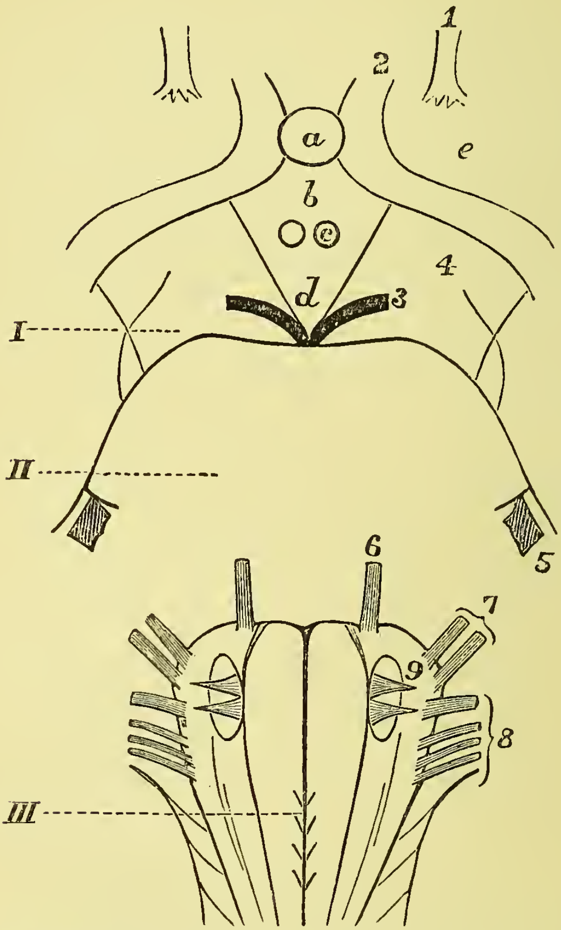
to the vagus and glosso-pharyngeal, and higher up to the auditory and sensory part of the fifth. Of the remaining four cranial nerves, the fourth arises from the valve of Vieussens; and the third arises from the grey matter around the aqueduct of Sylvius. For the optic and olfactory origins, *see* the description of these nerves.

The various *masses* met with at the base of the brain are—the under surface of frontal and temporo-sphenoidal lobes, pons Varolii, medulla oblongata, and cerebellum. The parts which occupy the *middle line* are, from before backwards, part of longitudinal fissure, optic commissure, tuber cinereum, infundibulum, pituitary body, corpora albicantia, and the posterior perforated spot.

On *either side of the middle line* we observe : the olfac-

tory tract and lobe, fissure of Sylvius, anterior perforated spot, optic tract, crus cerebri, from the inner side of which the third nerve is seen to emerge, and over which

Fig. 7.



I., Crus cerebri; II., pons Varolii; III., medulla oblongata, showing crossing of motor fibres in front. 1, olfactory or first nerve; 2, optic or second nerve; 3, motor oculi, the third nerve; 4, trochlearis or patheticus, the fourth nerve; 5, trigeminal, the fifth nerve, showing the small motor and the large sensory roots; 6, abduceus, the sixth nerve; 7, the auditory and facial nerves, the seventh nerve; 8, indicates the glosso-pharyngeal, pneumogastric, and spinal accessory nerves, the eighth nerve; 9, the hypoglossal, the ninth nerve. *a*, pituitary body; *b*, tuber cinereum; *c*, corpora albicantia; *d*, posterior perforated spot.

the fourth nerve curves; the motor and sensory roots of fifth nerve, appearing from the substance of the pons at its lateral aspect; the sixth nerve at the point of junction

between the pons and medulla. Behind all these is the medulla and the structures connected with it.

The Medulla Oblongata extends from the pons to the spinal cord. It consists of—1, anterior pyramids; 2, olivary bodies; 3, lateral tracts; 4, restiform bodies; 5, posterior pyramids. The *fibres* from the first *three* go chiefly to *cerebrum;* the *fibres* of the last *two* go chiefly to *cerebellum.* At the lower end of the anterior median fissure the crossing of the motor fibres of the cord can be seen. The following nerves are seen to arise from it:—

The *seventh* (facial and auditory) appears in a recess between the pons, cerebellum, and medulla. The *eighth* arises from the groove *behind* the olivary body, the *glosso-pharyngeal* having five or six roots, the *vagus* twelve or more, and the *spinal accessory* by a long series of roots, the lowest reaching as low as the sixth cervical.

The *ninth* appears in the groove in *front* of the olivary body.

I. The Olfactory Nerve consists of roots, tract, bulb, and branches. The *roots* are three—the external, white, arises from the island of Reil; the middle, grey, arises from the anterior perforated space; the internal, white, from the gyrus fornicatus. The *tract* passes forwards in a fissure on the under surface of the frontal lobe to the bulb. The *bulb* is an ovoid mass, lying on the cribriform plate on either side. The *branches* pass from the under surface of the bulb through the cribriform plate to the nose; there they are commensurate in their distribution with the ethmoid bone. They end in fine fusiform shape bodies—the cells of Max Schultze.

II. The Optic Nerve has its *origin* from the optic thalamus, corpora quadrigemina, and corpora geniculata. In its *course* forwards, it winds round the crus cerebri as a flat band—the *optic tract.* The opposite tracts unite to form the *optic commissure,* where an interchange of fibres takes place. From hence the nerve passes forwards to the optic foramen, enters the orbit, and reaches the eyeball; it then pierces the sclerotic and choroid coats, and becomes continuous with the retina.

III. The Motor Oculi, or third nerve, has its *origin* from the locus niger, and from the grey matter around the aqueduct of Sylvius. It *emerges* from the brain on the inner side of the crus cerebri. In its *course* forwards, it pierces the dura mater, enters the roof of the cavernous sinus, and runs along the outer wall of the sinus, to enter

the sphenoidal fissure between the heads of the external rectus muscle. The nerve has two *branches;* an *upper*, supplying the levator palpebræ and superior rectus; and a *lower* supplying the inferior oblique, inferior rectus, internal rectus, and the motor root to the lenticular ganglion.

IV. The Trochlear Nerve, patheticus or fourth nerve, *arises* from the valve of Vieussens. From hence it takes a *course* outwards around the crus cerebri, perforates the dura mater at the apex of the tentorium cerebelli, runs along the outer wall of the cavernous sinus, and enters the orbit through the sphenoidal fissure, above the two heads of the external rectus. The nerve is *distributed* to the superior oblique muscle on its orbital aspect.

V. The Trigeminal Nerve, trifacial or fifth nerve, has two *roots*, a motor and a sensory. The nerve *arises* in the floor of the fourth ventricle, the motor root from the upper part of the ventricle near the middle line, the sensory from the outer part of the ventricle along with the auditory (*see* Fourth Ventricle). The nerve *emerges* from the pons, midway between its centre and outer border, the upper root being the motor and much smaller than the sensory. In its *course* forward the two roots run together over the edge of the petrous portion of the temporal bone, and there the sensory root forms the *Gasserian ganglion*, which gives off three branches; the motor root continues its course *underneath* the ganglion, and joins its third branch as it is about to leave the skull. *Distribution:* From the anterior edge of the Gasserian, or semilunar ganglion, three branches are given off—viz., A. The ophthalmic. B. Superior maxillary. C. Inferior maxillary.

A. The *ophthalmic* nerve runs along the outer wall of the cavernous sinus, and before it enters the orbit subdivides into three branches—1. Frontal; 2. Lachrymal; 3. Nasal.

1. The frontal passes through the sphenoidal fissure, runs with the lachrymal above the external rectus muscle, and divides into two branches. (*a.*) The *supra-trochlear* passes out of the orbit above the oblique tendon to the occipito-frontalis, corrugator supercilii, and scalp. (*b.*) The *supra-orbital* nerve emerges from the supra-orbital foramen, and is distributed to the structures adjacent to the former.

2. The lachrymal nerve runs forwards along the upper edge of the external rectus muscle to be distributed in the lachrymal gland.

3. The nasal nerve enters the orbit between the two heads of the external rectus muscle, crosses to the inside of the optic nerve, and divides into two filaments: (*a.*) the *internal* or *nasal twig*, enters the anterior ethmoidal foramen, runs along the cribriform plate of the ethmoid, and passing through the nasal slit by the side of the crista galli, enters the nose. It here sends a few twigs to the nose, and finally emerging between the bone and the cartilage, supplies the skin as low down as the tip of the nose. (*b.*) The *infra-trochlear* emerges beneath the superior oblique muscle, and supplies the skin and lachrymal apparatus. The nasal nerve, before it divides, gives off a branch to the ophthalmic or *lenticular ganglion* and *two long ciliary nerves.*

The *lenticular ganglion* is situated between the external rectus muscle and optic nerve, and below the level of the ophthalmic artery. It is more or less quadrilateral in shape, and has entering it at its posterior inferior angle a motor filament from lower division of third, at its posterior superior angle a sensory filament from the nasal of fifth, and at its posterior border sympathetic filaments from the plexus around internal carotid. Ten or twelve short ciliary branches are given off from the ganglion, which perforate the sclerotic coat around the optic nerve and run forwards to supply the muscles of the iris.

B. The *superior maxillary* nerve passes through the foramen rotundum, crosses the spheno-maxillary fossa, traverses the infra-orbital groove, canal, and foramen, and is lost on the cheek.

The principal branches are:—

1. An orbital, which, running along the outer wall of the orbit, and receiving a branch from the lachrymal, divides into malar and temporal. The *malar* branch passes through the malar bone as the subcutaneous mali; the *temporal* branch reaches the skin through the temporal fascia a finger's breadth above the zygoma.

2. Filaments to Meckel's ganglion.

3. Posterior superior dental nerves; these enter the zygomatic surface of the superior maxilla and supply the teeth as far forward as the canine.

4. The anterior superior dental nerve descends in the anterior wall of the antrum to the incisor and canine teeth.

5. The infra-orbital nerve. The terminal branch comes out through the infra-orbital foramen, and forming a plexus with the infra-orbital branch of the facial, divides into *labial, nasal,* and *palpebral* branches.

Connected with this division we find *Meckel's ganglion.* This ganglion is found in the pterygo-maxillary fossa, below the level of the superior maxillary nerve, from which it derives its sensory roots, two in number. The motor and sympathetic roots are contained in the Vidian nerve, which enters the ganglion posteriorly. The *Vidian* nerve can be traced backwards through the Vidian foramen, and the cartilage that closes in the middle lacerated foramen; it resolves itself into motor and sympathetic roots—(*a.*) The motor is continued back beneath the Gasserian ganglion as the great superficial petrosal nerve to the hiatus Fallopii, along which it runs to join the facial; a branch from the tympanic plexus of glosso-pharyngeal, bestowing special sense, joins the nerve in the substance of the petrous portion of temporal. (*b.*) The sympathetic goes to join the carotid plexus.

The branches of distribution of Meckel's ganglion are—(*a.*) *Ascending* to periosteum of orbit. (*b.*) *Descending* through posterior palatine canal to the roof of the mouth, soft palate, tonsil, the levator palati and azygos uvulæ muscles. (*c.*) *Internal* or naso-palatine branches enter the superior meatus of the nose by the naso-palatine foramen, where they are distributed. One branch, however, runs down the septum of the nose as the naso-palatine nerve (Cotunnius), and gets by the anterior palatine foramen to the mouth. (*d.*) *Posterior*, or pharyngeal branch, passes back through pterygo-palatine foramen to supply the mucous membrane around the Eustachian tube.

C. The *inferior maxillary nerve* differs from the others in possessing a motor and sensory root. It *passes* out through the foramen ovale as two roots, but immediately the nerve enters the zygomatic fossa, the two join; the trunk of the nerve soon breaks up to form two sets of branches.

1. The anterior or motor set supplies the temporal, masseteric, buccinator, and pterygoid muscles.

2. The posterior or sensory set subdivides into three branches — (*a.*) The *auriculo-temporal* branch passes behind the neck of the lower jaw, sends branches to the parts about the ear, and finally accompanies the branches of the temporal artery. (*b.*) The *inferior dental* nerve

descends between the pterygoid muscles, enters the inferior dental foramen on the inner side of the ramus of the lower maxilla, gives filaments to *all* the lower teeth, and sends a branch out by the mental foramen to the chin, which is lost in the muscles of the lower lip and in the integuments. Before entering the dental canal, it gives off the *mylo-hyoid* nerve, which supplies the mylo-hyoid to the anterior belly of the digastric. (*c.*) The *lingual*, or *gustatory*, after being joined by the chorda tympani, descends between the jaw and the internal pterygoid muscle, then accompanies the Whartonian duct, and is distributed to the anterior two-thirds of the tongue, supplying tactile sensation, and possibly taste proper.

The *otic* ganglion is found in connexion with this division. It is situated upon the nerve to the internal pterygoid muscle, and its relations are—above, foramen ovale; externally, inferior maxillary nerve; internally, tensor palati muscle; behind, middle meningeal artery. The motor root is derived from the nerve to the internal pterygoid; the sensory root from the sensory trunk of inferior maxillary; and its sympathetic from the nerves around the middle meningeal artery. Its branches of distribution supply the tensor palati and tensor tympani muscles.

VI. The Abducens, or sixth nerve, *arises* from the upper part of the floor of the fourth ventricle, from a nucleus common to it and the seventh nerve. It *emerges* from the brain substance, between the anterior pyramid of the medulla, and the lower border of the pons. In its *course* forwards, it passes under cover of the posterior clinoid process, then along the side of the internal carotid artery to the sphenoidal fissure; there it passes into the orbit between the two heads of the external rectus muscle, the ocular surface of which it enters.

VII. The Portio Dura and the Portio Mollis together make up the seventh nerve. According to some anatomists they make the seventh and eighth cranial nerves.

A. The *portio dura arises* from the upper part of the floor of the fourth ventricle, from a nucleus in common with the sixth. It *emerges* in the recess between the medulla, pons, and cerebellum. It now enters the internal auditory meatus, to get to the aqueduct of Fallopius, along which it passes, and from which it finally emerges at the stylo-mastoid foramen. It then enters the parotid gland, and forming the pes anserinus, finally emerges from its

anterior border to supply the face. The branches given off are—1. Before it enters the temporal bone, it gives off branches to the auditory nerve. 2. In the temporal bone the nerve forms a swelling called the *Intumescentia gangliofonnis*. The branches given off are—*a*. The great superficial petrosal, going to join the Vidian, to supply Meckel's ganglion. *b*. The lesser superficial petrosal going to otic ganglion. *c*. The nerve to the stapedius muscle. *d*. The chorda tympani nerve enters the tympanum through the iter chordæ posterius, passes forwards between the handle of the malleus and the long process of the incus, and leaves the cavity of the tympanum by the iter chordæ anterius. It finally emerges from the bone, by the canal of Huguier, to join the gustatory nerve. Along this nerve it passes down to the submaxillary gland and the tongue. 3. When the facial nerve emerges from the stylo-mastoid foramen, it supplies —*a*. A posterior auricular branch. *b*. A branch to the posterior belly of the digastric muscle. *c*. A branch to the stylo-hyoid muscle. 4. In the parotid gland the nerve breaks up to form a plexus, the *pes anserinus*, and finally its branches are distributed as two sets.

The *temporo-facial* set gives off—*a*. Temporal. *b*. Malar. *c*. Infra-orbital branches, which supply the muscles in the regions the names indicate.

The *cervico-facial* set gives off—*a*. Buccal. *b*. Supramaxillary. *c*. Infra-maxillary branches; likewise supplying muscles in the regions of their distribution. The branches all form plexuses with the fifth nerve.

B. The *portio mollis*, or auditory portion, *arises* from the floor of the fourth ventricle from a nucleus common to this nerve and the sensory part of the fifth. It *emerges* from the brain and enters the petrous bone with the portio dura. It is distributed to the cochlea, vestibule, and semicircular canals.

VIII. The EIGHTH PAIR of nerves consists of three distinct groups. A. The glosso-pharyngeal, sometimes enumerated as the ninth, *arises* in the floor of the fourth ventricle, near the apex (*see* Fourth Ventricle). It *emerges* from the medulla, behind the olivary body, and *leaves* the skull through the jugular foramen. The nerve is then conducted by the stylo-pharyngeus muscle to the posterior third of the tongue, where it is *distributed*. On the nerve are two *ganglia*, the upper the jugular, the lower the petrosal. From the petrosal a *tympanic* branch, Jacob-

son's nerve, is given off; and from hence six branches are to be made out, three being branches of distribution—viz., (*a*) to the fenestra ovalis, (*b*), to the fenestra rotunda, (*c*) and to the Eustachian tube; three are branches of communication—viz., (*a*) to the great superficial petrosal, (*b*) to the lesser superficial petrosal, (*c*) to the sympathetic on the internal carotid artery. The *branches* of the nerve itself are:—1, carotid, to the carotid artery; 2, muscular, to the stylo-pharyngeus; 3, pharyngeal, to the pharyngeal plexus; 4, tonsilitic, to the tonsil, around which it forms a circle, the circulus tonsillaris; 5, lingual, to the posterior third of the tongue.

B. The vagus, pneumogastric, or tenth cranial pair, *arises* from the floor of the fourth ventricle near the apex (*see* Fourth Ventricle). It *emerges* below the level of the glosso-pharyngeal, from the side of the medulla and behind the olivary body. It *leaves* the skull by the jugular foramen, and descends between the jugular vein and carotid artery to the thorax. In the thorax it is found forming a plexus behind the root of the lungs, from which on either side the nerve again emerges, and, having passed down along the œsophagus, enters the abdomen by the œsophageal opening, to be lost on the stomach, liver and neighbouring parts. There is a slight difference between the courses of the right and left vagi, as they descend to, and enter, the thorax. The *right* nerve is placed more anteriorly than the left, and crosses between the subclavian artery and vein at a right angle on the inner side of the anterior scalene; the *left* nerve crosses obliquely the origin of the subclavian artery, and then passes over the second part of the arch of the *aorta*.

Immediately below the jugular foramen, two *ganglia* are developed on the nerve. The *upper*, the ganglion of the root, gives off communicating branches to the neighbouring nerves; and one named branch, the *auricular* (Arnold's nerve), enters a foramen in the jugular fossa, and emerges at the auricular fissure behind the ear. The *lower* ganglion, about an inch in length, gives off at its upper part the pharyngeal branch, and at the lower part the superior laryngeal. The pneumogastric and spinal accessory nerves unite beyond the ganglion of the trunk. The principal *branches* of the pneumogastric nerve are:—

1. Communicating branches to the neighbouring cranial nerves and the superior cervical ganglion.

2. The pharyngeal nerve, arises by two roots, one from the upper part of the ganglion of the trunk of the pneumogastric, the other from the spinal accessory. The nerve now descends behind the internal and external branches of the carotid artery, in an oblique direction, to the middle constrictor of the pharynx, on which, with branches from the spinal accessory, glosso-pharyngeal, superior laryngeal nerves, and superior cervical ganglion, it forms the *pharyngeal plexus;* from this plexus, filaments are sent off to the mucous and muscular tissues of the pharynx.

3. The superior laryngeal nerve arises by two roots, one from the lower part of the ganglion of the trunk of the pneumogastric, the other from the spinal accessory. The nerve soon divides into two branches—(*a*) the external laryngeal nerve supplies the crico-thyroid muscle; (*b*) the other, the continuation of the nerve, penetrates between the os hyoides and thyroid cartilage, and is distributed to the mucous membrane of the larynx; it also gives filaments to the mucous membrane at the base of the tongue and to the arytenoideus muscle.

4. Cardiac branches, which descend to the cardiac plexuses.

5. Inferior or laryngeal recurrent nerve, given off just as the vagus is about to enter the thorax; that of the right side winds round the subclavian artery, from before backwards, and then ascends, obliquely inwards, to the trachea, until it reaches the edge of the inferior constrictor, under which it passes to be distributed to the crico-arytenoid, thyro-arytenoid, and arytenoid muscles; it also gives filaments to the mucous membrane. The left recurrent nerve is longer than the right, and winds round the arch of the aorta.

6. In the chest, the pneumogastric nerves descend through the posterior mediastinum to the root of the lungs, where they break up to form the *pulmonary* plexuses, from which a great number of filaments are sent off along the several ramifications of the bronchi.

7. Œsophageal cords. From the inferior portion of the above plexuses the pneumogastric nerves emanate, one of which (the left) descends rather anteriorly—the other (the right) rather posteriorly—along the œsophagus, to the œsophageal opening in the diaphragm, through which they pass to terminate in the stomach, and in the solar and hepatic plexuses.

C. The spinal accessory nerve (the eleventh cranial pair), *arises* from a nucleus below the apex of the fourth ventricle, and behind the central canal of the spinal cord. The nerve also receives fibres of origin from the side of the spinal cord as low down as the sixth cervical. These ascend between the roots of the spinal nerves, passes through the foramen magnum, and becoming closely applied to the pneumogastric, passes along with it through the jugular foramen. The nerve now divides into two—(*a*) one branch passes backwards through the sterno-mastoid muscle, across the posterior triangle of the neck, to the under surface of the trapezius. This nerve supplies both the sterno-mastoid and the trapezius muscles. (*b.*) The other branch joins the pneumogastric beyond the ganglion of the trunk.

IX. The ninth or hypoglossal nerve (the twelfth nerve), *arises* by a nucleus at the apex of the fourth ventricle; it *emerges* from the medulla in front of the olivary body, and leaves the skull through the anterior condyloid foramen. The nerve now becomes closely blended with the ganglion of the trunk of the pneumogastric, then gradually parting with it, descends for some distance between the internal jugular vein and the trunk of the carotid artery. Finally, the nerve crosses the carotid arteries, passes forward upon the hyo-glossus muscle, to terminate in the muscles of the tongue.

The *branches* are:—

1. Communicating branches at the base of the skull to the neighbouring nerves.

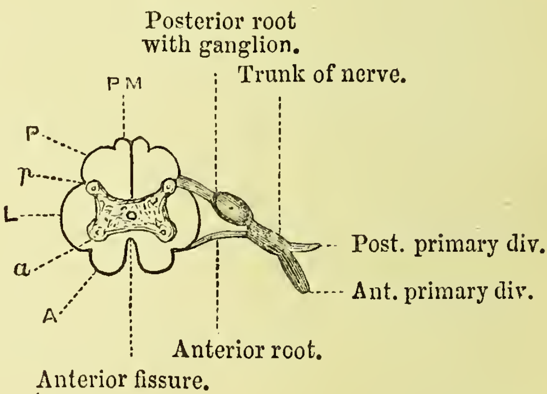
2. The descendens noni descends upon the sheath of the carotid artery, forms a plexus, the *ansa hypoglossi* with the communicantes noni from the cervical nerves, and supplies the following muscles:—the sterno-hyoid, the sterno-thyroid, and both bellies of the omo-hyoid. The nerve ends on one or both sides by communicating with the phrenic.

3. Branches to all the muscles at the base and in the substance of the tongue—viz., the genio-hyoid, the genio-hyo-glossus, the hyo-glossus, the stylo-glossus, the palato-glossus, the superficial, transverse, and inferior linguales muscles.

THE SPINAL CORD.

Occupying the neural arch of the vertebræ, from the first cervical to the first lumbar vertebra, is the spinal cord. It does not fill the bony canal, but between it and the bones are plexuses of veins, the dura mater, the sub-dural space, the arachnoid, the sub-arachnoid space, and the pia mater. The cord has for the most part a rounded appearance, but becomes enlarged and flattened in the cervical and lower dorsal regions. The lower end comes suddenly to a point, and an enormous leash of nerves arises from around it. It resembles a horse's tail, the end of the cord being the stump, and the nerves the

Fig. 8.



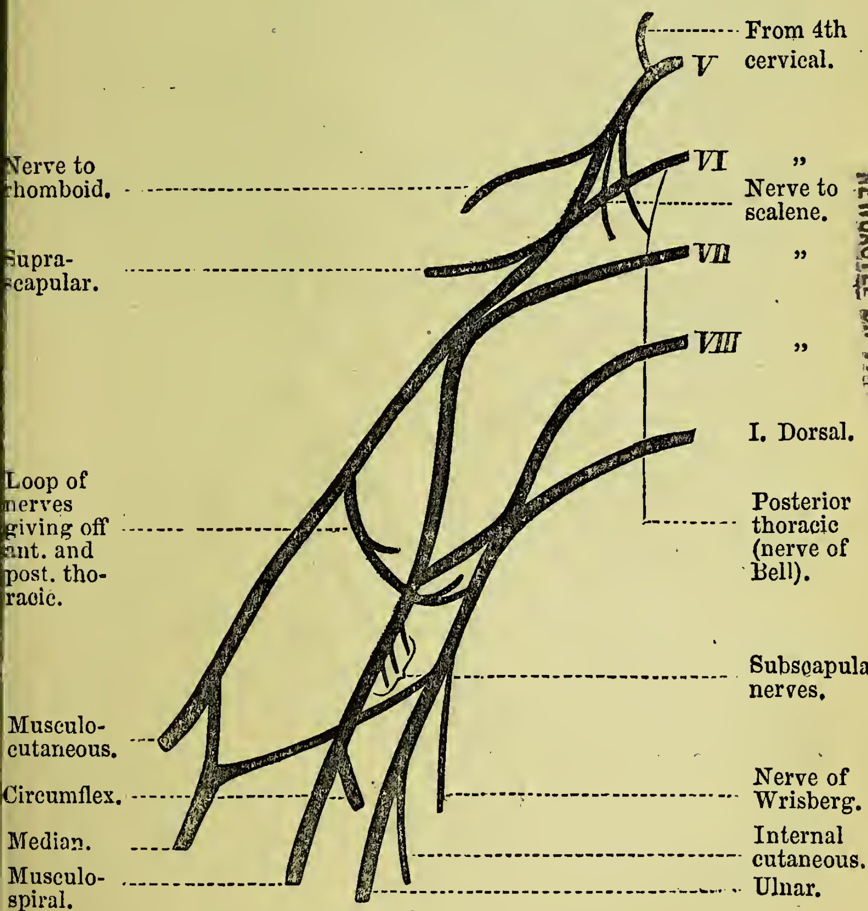
A, anterior column; L, lateral column; P, posterior column; P M, posterior median column; *a*, the anterior cornu of the grey matter; *p*, the posterior cornu of the grey matter. The anterior or motor root is seen to be smaller than the posterior or sensory root. The anterior fissure is seen to be wider than the posterior, but not so deep; the posterior fissure reaches down to the grey matter, the anterior falls short of it. It will be observed that the roots join *beyond* the ganglion.

hairs; hence it is spoken of as the *cauda equina*. The canal, below where the cord ends, is occupied by the lumbar and sacral nerves, passing to the foramina, from which they emerge. A *section* of the spinal cord shows the grey matter in the centre and the white matter around it. The grey matter forms an anterior and posterior *cornu* on either side, with which the roots of the nerves are more or less intimately connected (*see* Fig. 8).

The white matter is arranged in *columns*—anterior, lateral, posterior, and posterior median columns.

The Spinal Nerves are:—8 cervical, 12 dorsal, 5 lumbar, 5 sacral, and 1 coccygeal—31 in all. The nerves pass out from the spinal canal through the intervertebral foramina. Immediately on emerging from the foramina, they divide into an anterior and posterior primary division. The *posterior primary division* divides into two

Fig. 9.—Brachial Plexus.

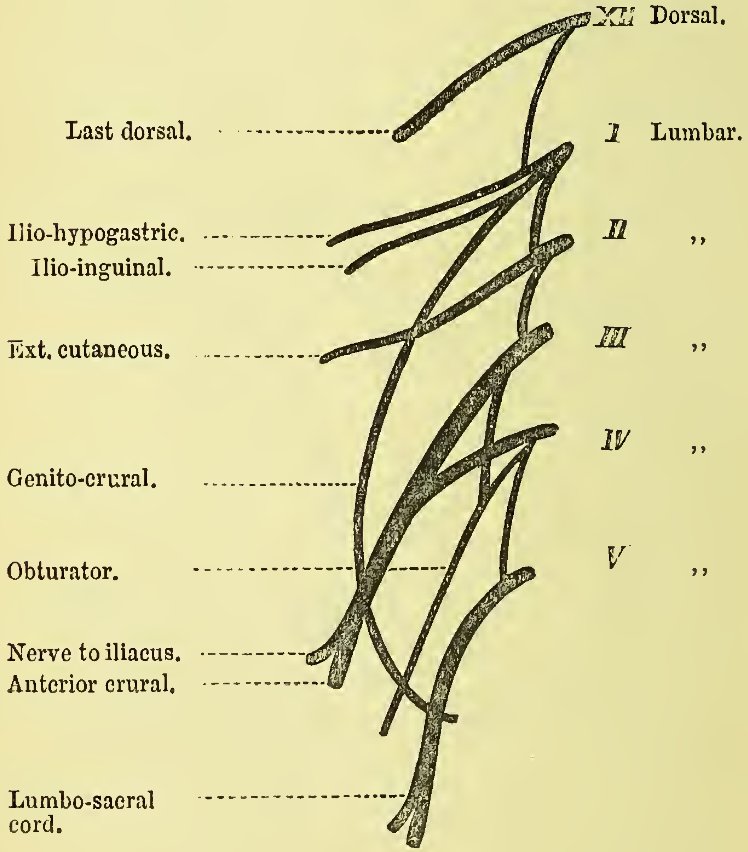


branches, internal and external, and these are distributed to the skin and muscles of the back. The *anterior primary division* of the nerves join to form *plexuses*. This is true in the neck, lumbar, and sacral regions; but the anterior divisions of the dorsal nerve run forward to form *the intercostal nerves*. These run underneath the lower edge of a rib, and are conducted forwards to the middle line. The branches are:—*Lateral cutaneous branches* given

off at the sides of the chest. *The terminal branches* appear on either side of the sternum and linea alba, and dividing into an internal and external branch, supply the skin.

The various plexuses formed by the anterior primary divisions of the spinal nerves will be readily understood from the diagrams (Figs. 10, 11, 12).

FIG. 10.—LUMBAR PLEXUS.



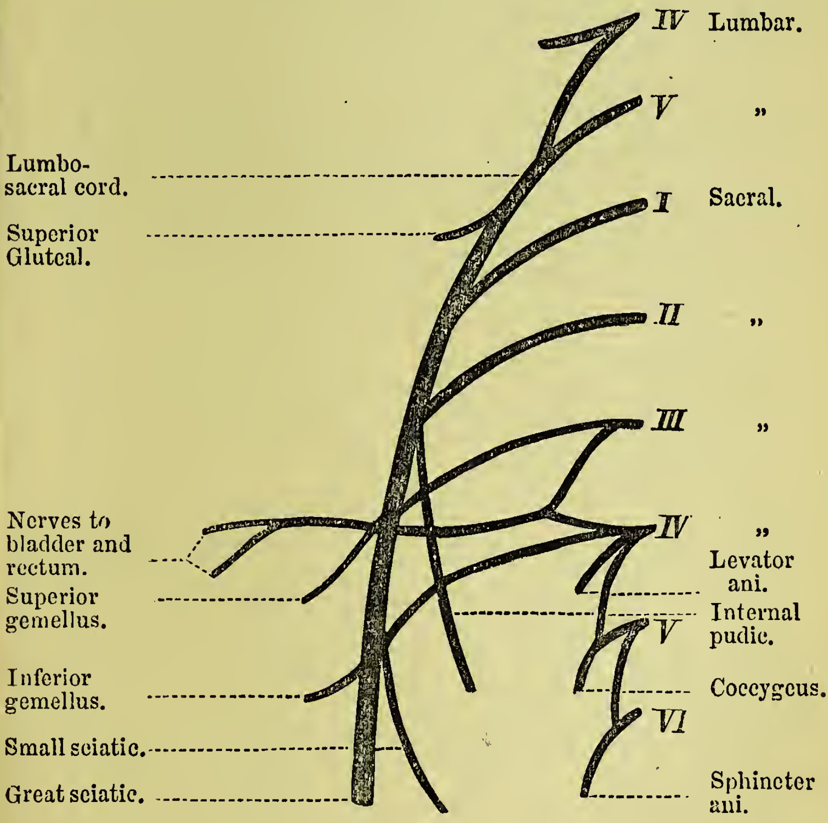
THE ORBIT.

The ORBIT is a conical shaped bony cavity, with the apex backward at the optic foramen, and the base forwards at the face.

The bones forming the *base* are the frontal above, the superior maxilla internally, and the malar bone externally and below. The *cavity* of the orbit presents surfaces and

angles. The *surfaces* are—the *roof*, formed by the frontal bone and the lesser wing of the sphenoid; the *floor*, by the superior maxilla, malar, and palate bones; the inner wall by the os planum of ethmoid, lachrymal and sphenoid bones; the outer wall by the malar bone and great wing of the sphenoid. The *angles* are—superior internal, presenting the anterior and posterior ethmoidal foramina; inferior internal; superior-external with the

Fig. 11.—Sacral Plexus.

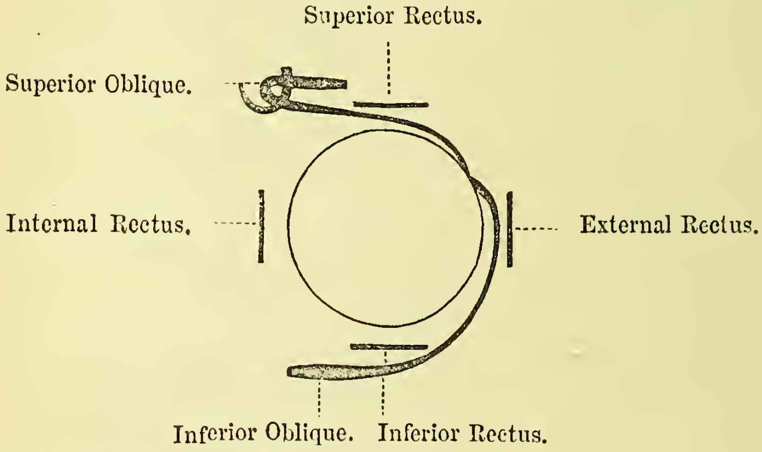


sphenoidal fissure at the posterior part; and inferior-external with the spheno-maxillary fissure at the posterior part.

The orbit is lined throughout by periosteum, continuous, behind with the dura mater, and in front with the periosteum of the face. The *muscles* are seven in number. Four recti muscles arise from the ligament of Zinn, a fibrous ring around the optic nerve; the levator palpebræ and superior oblique arise from the lesser wing of

sphenoid above the optic foramen; and the inferior oblique arises close to the margin of the orbit from the superior maxillary bone. The recti muscles are inserted into the sclerotic coat a quarter of an inch behind the cornea. The levator palpebræ goes to the tarsal cartilage in the upper eyelid. The oblique muscles pass, as Fig. 12 best shows, to be inserted close together between the superior and external rectus. The *blood-vessels* in the orbit are chiefly branches of the ophthalmic artery and vein. The artery comes from the internal carotid, passes through the optic foramen with the optic nerve, and then lies first on the outside, then on the top, and

Fig. 12.—Transverse Vertical Section of Eyeball, showing relations of Recti and Oblique Muscles.



then to the inside of the optic nerve. It gives three branches in each stage:—

1. When *outside* the nerve: (*a*) the lachrymal, (*b*) the arteria centralis retina, and (*c*) muscular branches. 2. When *above* the nerve: (*a*) posterior ciliary, (*b*) supra-orbital, and (*c*) muscular. The posterior ciliary consist of two long branches and about a dozen short. 3. When *inside* the nerve: (*a*) anterior, (*b*) posterior ethmoidal, and (*c*) muscular. 4. The terminal branches are: (*a*) frontal, (*b*) nasal, and (*c*) palpebral. The ophthalmic vein leaves the orbit between the two heads of the external rectus muscle, and gets through the sphenoidal fissure to join the cavernous sinus. The description of the *nerves* in the orbit, the second, third, fourth, first division of

the fifth, and the sixth, will be found under cranial nerves. They enter the orbit by the optic foramen and the sphenoidal fissure. Those coming through the fissure are divided by the external rectus into two groups—one, above the muscle, consists of the fourth, frontal, and lachrymal nerves; the other, between the two heads of the muscle, consists of the upper division of the third, the nasal branch of the fifth, and the lower division of the third, and the sixth nerves, in order from above.

THE EYE.

Situated within the bony orbit, resting on fat, and surrounded by muscles, is the eye-ball. Around it are tissues placed so as to allow of its movement on neighbouring structures—viz., the conjunctiva in front, and the capsule of Tenon behind. The various structures have also distinct functions, the sclerotic a protective, the choroid a vascular, and the retina a visual. In the centre are the various media, the cornea, aqueous humour, lens, and vitreous humour.

The Conjunctiva is the mucous membrane covering over the front of the eye. It consists of an *ocular* portion, where it is reflected over the eyeball, and a *palpebral* where it lines the inner surface of the lids. Over the front of the cornea it is clear and transparent, and is incorporated with its tissue. Opening into it at the outer angle of the orbit are the lachrymal ducts, and at the inner end the two puncta lachrymalia.

The Capsule of Tenon is a lymphatic sheath covering the eyeball behind where the conjunctiva touches.

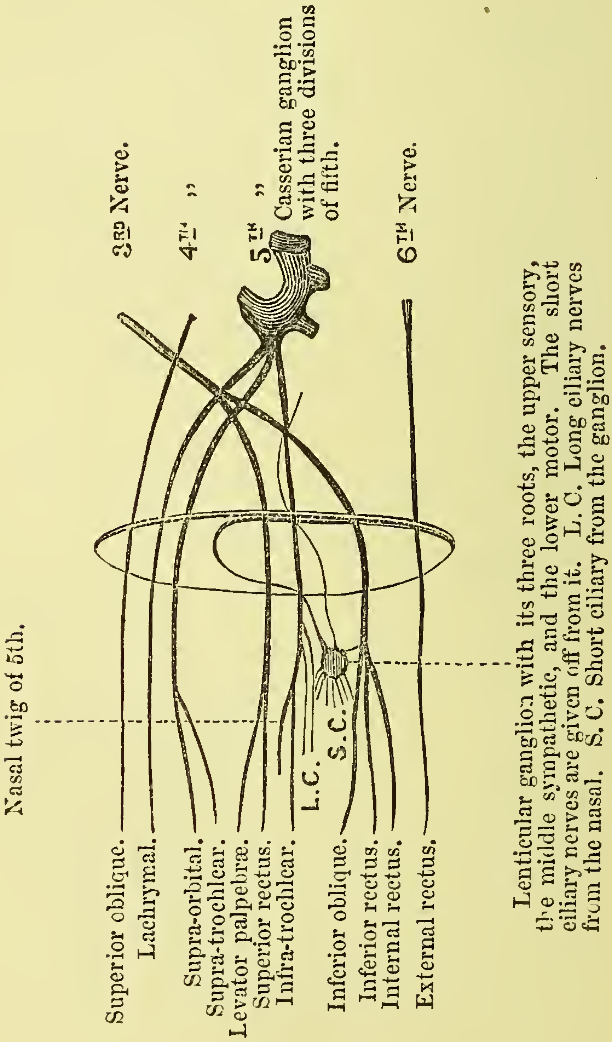
The Sclerotic Coat, with the cornea, determines the shape and size of the eye. The cornea forms the anterior one-fifth, the sclerotic the posterior four-fifths. The eye *measures* in its *transverse* diameter *one inch*, and in its *antero-posterior* and *perpendicular* diameters ·91 inch.

The sclerotic coat consists of dense fibrous tissue, continuous in front with the tissue of the cornea, and behind it is perforated by the optic nerve, forming the *lamina cribrosa*.

The sclerotic coat has the *recti muscles* inserted into it, one-fourth of an inch behind the cornea, and the *two oblique* muscles behind that; half way back it is perforated by the *veins* leaving the eyeball to join the ophthalmic;

FIG. 13.—DIAGRAM OF THE RELATIONS OF THE NERVES AS THEY ENTER THE ORBIT THROUGH THE SPHENOIDAL FISSURE.

The large outer circle represents the Sphenoidal Fissure ; the smaller one, the interval between the heads of the External Rectus.



behind these the two *long ciliary* arteries and nerves perforate the coat, one set on either side; and still further back the *short ciliary* arteries and nerves enter in a group around the optic nerve.

The CORNEA presents, from before backwards, *layers of cells* continuous with the conjunctiva; a condensed portion of the corneal tissue called the *anterior elastic lamina;* the layers of the cornea proper, a *fine fibrous tissue layer*, with lymph spaces and corpuscles. The fibrous tissue is limited posteriorly by the *posterior elastic lamina*, and this again is covered behind with a single layer of cells, the *membrane of Demours*, forming the anterior boundary of the aqueous humour.

The CHOROID is the vascular coat of the eye, and lies within the sclerotic. It is continuous in front with the iris, and behind is perforated by the optic nerve. The various structures met with in connection with the choroid in order from without inwards are—the *membrana fusca*, a delicate reticulum of fibrous tissue, between the sclerotic and choroid; the *ciliary vessels and nerves* passing forwards; the plexus of veins, the *vasa vorticosa;* the *choroidal tissue proper*, consisting of fine fibrous tissue, with branched connective-tissue corpuscles containing pigment; and the *tunica Ruyschiana*, a fine plexus of blood-vessels forming the inner layer of the choroid. In front the choroid is continued into the iris, and at their junction is seen a white band, the *ciliary muscle*. Underneath this white band is found a number of processes called the *ciliary processes;* they form the connection between the choroid and iris; they consist of processes containing blood-vessels and covered over by pigment; they are as many as eighty in number. The under surface of these processes are firmly connected to the suspensory ligament of the lens.

The IRIS acts as a shade or blind to the retina within. In its centre is the pupil, varying in size, according to the intensity of the light. The iris consists of a *delicate reticulum of fibrous tissue*, covered over, anteriorly by a *layer of cells* continuous with those from the back of the cornea, and posteriorly by layers of pigment cells—*the uvea*. In the fibrous tissue are found muscles, vessels, nerves, and lymphatics. The *muscles* are of two sorts, circular and radiating. The *circular* fibres are arranged round the pupil, forming a *sphincter;* the *radiating* fibres pass from the margin towards the pupil,

forming the *dilatator*. The *vessels* are derived from the ciliary, and form two circles: the one around the outer part of the iris, and the other near the pupil. They are called the *circulus iridis major* and *circulus iridis minor*. The *nerve* supplying the dilatator is the sympathetic through the ciliary; the nerve supplying the sphincter is the third also through the ciliary.

The Ciliary Muscle arises at the junction of the cornea and sclerotic, and is inserted into the junction of the iris and choroid obscuring the continuation of the two. As already mentioned, the junction between the iris and choroid is effected by the ciliary processes, and the ciliary muscle comes to be inserted into them. These processes are in turn blended with the *suspensory ligament* of the lens, and so act on the capsule and the lens itself by increasing or diminishing its convexity and density.

The Retina is regarded as being a terminal nerve organ of the optic nerve. The primary optic vesicle in the developing fœtus buds forth from the brain substance, and, meeting the epithelial structures in the orbital region, the anterior part becomes cupped and pushed back within the concavity of the vesicle. The part thus involuted becomes the retina, and the outer part of the vesicle becomes the pigmentary layer of the retina. Thus the visual part of the retina has externally to it *a pigment layer*, consisting of a single layer of hexagonal pigment cells. It is this layer which advances to the iris to form the *uvea*, where the cells are five or six deep. The retina has internal to it the hyaloid membrane and the vitreous humour. Anteriorly the visual portion ends at the *ora serrata;* but the connective-tissue part of the retina is continuous in front with the suspensory ligament of the lens. The *layers of the retina* from within outwards are—1. The internal limiting membrane. 2. The nerve fibre layer. 3. The ganglionic layer. 4. The inner molecular layer. 5. The inner nuclear layer. 6. The outer molecular layer. 7. The outer nuclear layer. 8. The external limiting membrane. 9. The layer of rods and cones. On the rods and cones the image is formed, and the light is prevented passing further by the pigment. When the pigment is absent the vessels of the choroid shine through and form the red pupil of the Albino. The point of most acute vision is the *yellow spot of Sömmerring*, with the *fovea centralis*

in its centre. Of the layer of rods and cones, the cones are alone present at the spot, and the branches of the arteria-centralis retina avoid it. It is straight in the axis of vision, and about one-tenth of an inch external to the entrance of the optic nerve.

The MEDIA through which the light travels consist—1. Of the *cornea* already discussed. 2. The *aqueous humour* or fluid, which is bounded in front by the cornea and behind by the lens, constituting the *aqueous chamber*. It is divided by the iris, which hangs free in it, into an anterior and posterior chamber.

The LENS is the apparatus by which the rays of light, emerging from any illuminated body, are so arranged and grouped as to form an exact image on the retina. It measures one-fifth of an inch from before backwards, and one-third of an inch from side to side. It is bi-convex, with its greatest convexity behind. It is enclosed in a capsule, which at the sides is connected with the hyaloid membrane, and the suspensory ligament of the lens. Its convexity is altered by the action of the ciliary muscle on the suspensory ligament. The lens is *composed* of nucleated hexagonal fibres, fitting exactly into each other by serrated edges. The fibres run from the anterior to the posterior surface around the margin. They are fixed to connective tissue processes radiating from the poles.

The VITREOUS HUMOUR fills the main part of the concavity of the eye. It is a transparent gelatino-mucous substance, consisting of fine cells with branched processes, in the meshes of which a fluid yielding mucin is found. The hyaloid membrane surrounds the vitreous humour. At the edge of the lens the hyaloid membrane and the suspensory ligament of the lens enclose between them a space, called the *canal of Petit*. External to this canal the tissues of the two are so closely blended that it looks as though the hyaloid membrane split to form the boundaries of the canal.

THE EAR.

The external ear consists, for the most part, of yellow fibro-cartilage, so arranged as to conduct the waves of sound first into the concha and then into the *external auditory meatus*. The meatus is one inch and a quarter in length, and has at its inner end the membrana tympani. It is composed, for the outer half inch of its course,

of cartilage; and for the inner three-quarters of an inch, of bone. It is slightly convex, so that its floor bulges upwards about the middle of its course. Numerous *ceruminous* glands are found in the canal.

The TYMPANUM is situated within the membrana tympani, and contains the bony ossicles. It is bounded *above* by a piece of bone between it and the cranial cavity; *below* by a plate of bone between it and the jugular fossa; *in front* it has the openings for the Eustachian tube and the tensor tympani muscle; *behind* the openings of the mastoid cells; *externally* the membrana tympani; and *internally* the inner wall of the tympanum. The cavity measures from without inwards, one-fifth of an inch, and obliquely from above downwards, about one-third of an inch.

The MEMBRANA TYMPANI is a fine glassy-like membrane, lined internally by the mucous membrane of the tympanum, and externally by the epithelial lining of the external auditory meatus. Between the two is the fibrous tissue of the membrane, arranged in lines running from the centre to the circumference, and again a fine circular band at the circumference. The membrane is convex inwards, and to the apex of the convexity the long processes of the malleus is attached. It is fixed at an inclination of 45°.

The EUSTACHIAN TUBE is an osseo-cartilaginous tube, communicating with the pharynx below, and opening above into the anterior part of the tympanum. The lower, or cartilaginous portion is one inch in length, and the upper or osseous half an inch. Its lower end is open and trumpet-shaped, and placed opposite the inferior meatus of the nose. It transmits air to the tympanum.

The BONES contained in the tympanic cavity are—1. The *malleus*, shaped like a hammer or rather a club. It consists from above downwards of an apex, head, neck, and processes. The processes are—the manubrium, or handle, fixed to the membrana tympani; the short process; and the processus gracilis, running down into the Glaserian fissure. 2. The *incus*, like an anvil in shape, has a flattened surface to articulate with the malleus; a short posterior process; and a long process, which projects downwards and inwards to articulate with the stapes. 3. The *stapes*, like a stirrup, articulates with the incus by a round knob, called the *os orbiculare;* below this is the neck, two processes, and

then the crossbar of the stirrup, fitting into the *fenestra ovalis*. Running through the tympanum, between the long processes of the incus and the handle of the malleus, is the chorda tympani. It enters by the iter chordæ posterius, and emerges in front through the iter chordæ anterius, placed on the posterior and the anterior walls of the tympanum. The *inner wall* of the tympanum presents the *fenestra ovalis*, against which the stapes is applied; the *fenestra rotunda*, over which is stretched the *secondary membrane* of the tympanum; the *promontory*; the *pyramid*, with the *stapedius* muscle emerging from it.

The Muscles of the tympanum are—1. The tensor tympani arises from the Eustachian tube, and the tip of the petrous portion of the temporal bone; it passes up through a bony canal, parallel to, but above the level of, the Eustachian tube, and separated from it by the processus cochleariformis. The muscle goes to be inserted into the malleus. 2. The laxator tympani arises from the spinous process of the sphenoid, passes through the Glaserian fissure, and goes to be inserted in the malleus. 3. The stapedius muscle emerges from the apex of the pyramid, within which it arises, and goes to be inserted into the neck of the stapes. It serves to prevent the stapes being driven too strongly against the membrane closing the fenestra ovalis.

The description of the *internal ear* cannot be entered into in detail here.

1. The vestibule is a small ovoidal space on the inner side of the tympanum; it communicates in front with the cochlea, and behind with the semicircular canals. In its roof and inner wall are found the fovea hemispherica and hemi-elliptica, through which branches of the auditory nerve enter. Contained within the vestibule are the utricle and the saccule, two membranous sacs on which the auditory nerve is distributed in part.

2. The semicircular canals are three in number—superior, posterior, and external. They are composed of bony walls, within which are found the membranous canals. Both the bony and the membranous, possess at one end a dilated portion called an *ampulla*. Between the bone and the membrane is found the perilymph, and within the membranous canals the endolymph; on the membranous ampullæ the auditory nerve is distributed.

3. The cochlea is a spiral coil of bone with its base

backwards, communicating with the vestibule and its apex forwards. It measures $\frac{1}{4}$ in. from apex to base, but $1\frac{1}{2}$ in. along its canals. The central pillar is called the *modiolus.* On the outer wall of the modiolus, a piece of bone, the *lamina spiralis*, projects about half the distance across the cavity of the cochlear tube, the distance is completed by a membrane, the *membrana basilaris*, and thus the cochlear is divided into two scalæ, the *scala vestibuli*, and the *scala tympani.* The scala vestibuli, the upper, is further apportioned off by the *membrane of Reissner*, which cuts off a third canal, the *central canal of the cochlea.* On the membrana basilaris are found the *organs of Corti ;* these are considered the terminal nerve ends of the cochlear branch of the auditory nerve, and consist of two rows of rods, an outer and inner, each of which are connected with the endings of the auditory nerve. The inner rods are the more numerous.

THE TRIANGLES OF THE NECK.

The side of the neck is quadrilateral in shape, bounded below by the clavicle, above by the lower jaw and occiput, in front by the middle line, and behind by the trapezius. The sterno-mastoid muscle passes obliquely across this space from the anterior inferior angle at the top of the sternum, to the posterior superior angle at the occiput. It consequently divides the side of the neck into two triangles, an anterior, and a posterior.

The Posterior Triangle is again divided into two by the posterior belly of the omo-hyoid muscle; one triangle being above, the other below the muscle.

I. The occipital triangle is *bounded* in *front* by the sterno-mastoid, *behind* by the trapezius, *below* the base is formed by the omo-hyoid muscle, and the apex above is formed by the meeting of the sterno-mastoid and trapezius, on the superior curved line of occiput. The *roof* is formed by the skin, superficial fascia, small part of platysma, and deep fascia. The *floor* is formed from above downwards, by the splenius capitis, levator anguli scapulæ, posterior and middle *scalene* muscles. In the roof is found the superficial cervical plexus of nerves ; in the floor, the nerves to the rhomboid and serratus magnus muscles; in the triangle, the spinal accessory nerve, the transversales colli and humeri arteries and

veins. The occipital artery and great occipital nerve perforate the apex.

II. The subclavian triangle is *bounded* above by the posterior belly of the omo-hyoid muscle, below by the clavicle, and internally the base is formed by the sterno-mastoid. The *roof* is formed by the skin, superficial fascia, platysma, and deep fascia; the *floor* by the first rib and the first serration of serratus magnus. *In the roof* is found a plexus of veins, formed by the transversales colli and humeri veins joining the external jugular, and descending branches of superficial cervical plexus of nerves—viz., sternal, clavicular, and acromial. *In the triangle* are found—the third stage of the subclavian artery and vein, the transversales humeri and colli vessels, the cords of the brachial plexus, and the nerve to the subclavius muscle. The relations of the subclavian artery are given with the upper extremity.

The ANTERIOR TRIANGLE of the neck is divided into two by the anterior belly of the omo-hyoid, one triangle above and the other below the muscle.

III. The inferior carotid triangle is *bounded* above by the omo-hyoid, externally by the sterno-mastoid, and internally by the middle line of the neck. The apex of the triangle is below. The *roof* is formed by the common structures; the *floor* by the sterno-hyoid and sterno-thyroid muscles. *In the roof* are found the anterior jugular vein and the superficial cervical nerve; *in the floor*, the descendens noni nerve; *beneath the floor*, the common carotid artery, with the internal jugular vein and pneumogastric nerve; *in the triangle*, nothing.

IV. The superior carotid triangle is *bounded* above by the posterior belly of the digastric and stylo-hyoid muscles; in front by the anterior belly of the omo-hyoid; behind by the sterno-mastoid. The *roof* of the triangle is formed by the common structures; the *floor* by the thyro-hyoid, hyo-glossus, and inferior and middle constrictor muscles of the pharynx. *In the roof* is found the superficial cervical nerve; *in the triangle* numerous arteries, veins, and nerves:—

The *arteries* are:—1. The common carotid, dividing into—2, internal carotid, and 3, external carotid. The external carotid gives off in this space, 4, the superior thyroid, giving off its branches—5, lingual, 6, facial, 7, ascending pharyngeal, and 8, occipital.

The *veins* are—the internal jugular, being joined by,

the superior thyroid, lingual, facial, ascending pharyngeal, and occipital veins, and the communicating branch to the external jugular.

The *nerves* are—I. The hypoglossal nerve, with its branches, 1, the descendens noni, and 2, the branch to thyro-hyoid muscle; II. The pneumogastric nerve, with its 1, superior laryngeal branch, from which is given off, 2, the external laryngeal; III. The sympathetic cord. A number of lymphatic glands lie in and upon all the triangles of the neck.

The middle line of the neck is an important region surgically; it reaches from the chin to the top of the sternum. Commencing at the chin and going down, there will be found in the floor—the mylo-hyoid muscles, the hyoid bone, the thyro-hyoid membrane, the thyroid cartilage, the crico-thyroid membrane, the cricoid cartilage, the rings of the trachea, with the isthmus of the thyroid gland opposite the third ring. The space is limited on either side, from above downwards, by the anterior bellies of the digastric, the thyro-hyoid muscles, and the sterno-hyoid and thyroid muscles. The anterior jugular veins run down one on either side of the middle line.

The Parotid Region is occupied by the parotid gland. It is *bounded* in front by the ramus of the jaw and the masseteric muscle; above by the zygoma and the external auditory meatus; behind and above by the mastoid process; behind and below by the sterno-mastoid muscle, and more deeply by the posterior belly of the digastric. It is separated from the submaxillary gland by the stylo-maxillary ligament, a process of deep cervical fascia. *Over* the gland lie the superficial structures, with the great auricular nerve. *In* the gland are found the facial nerve, forming the pes anserinus, beneath which is the commencement of the external jugular vein, and beneath the vein the external carotid artery dividing into its terminal branches. *Beneath* the gland is the styloid process, on which the gland splits. The duct of the parotid, Stenson's duct, passes across the masseteric muscle, and pierces the buccinator muscle opposite the second upper molar tooth. The course of the duct is found by taking a line from the lobule of the ear forwards to a point midway between the nose and mouth; bisect the line thus drawn, and the posterior half will be found to be occupied by the duct.

The submaxillary region is the space between the lower jaw and the hyoid bone. The digastric muscle found in this space maps out the following :—

V. The submaxillary triangle.—This triangle is *bounded* internally by the anterior belly of the digastric, posteriorly by the posterior belly of the digastric and stylo-hyoid muscles, above or externally by the lower jaw. It is separated from the parotid region by the stylo-maxillary ligament, a process of deep cervical fascia. The *roof* is formed by the usual cutaneous structures, the *floor* by the mylo-hyoid muscle. *In the roof* are found the radicles of the anterior jugular vein and the infra-maxillary branch of the facial nerve; *in the triangle* are found the submaxillary gland, the facial vessels and their branches, and the mylo-hyoidean artery and nerve. In proceeding with the dissection of this space from the surface to the middle of the tongue three muscles will be met with.

Dissection of Submaxillary Region.

1. The mylo-hyoid muscle, *triangular* in shape, with a free border behind, round which hooks the submaxillary duct—Wharton's duct. *On* the mylo-hyoid muscle, *three* sets of structures will be found—*a*. The submaxillary gland. *b*. The facial vessels and their branches. *c*. The mylo-hyoidean artery and nerve.

2. The hyoglossus muscle, *quadrilateral* in shape, passes from the hyoid bone to the tongue, with a free border in front and behind. *On* the hyoglossus muscle *three* sets of structures lie—*a*. The gustatory nerve, with the submaxillary ganglion. *b*. Wharton's duct. *c*. The hypoglossal nerve.

3. The genio-hyoglossus muscle, as its name implies, passes from the genial tubercle to the hyoid bone and the tongue. It is shaped like a *fan*. On the genio-hyoglossus muscle *three* sets of structures are found—*a*. The lingual artery; *b*. The stylo-hyoid ligament; and *c*. The glosso-pharyngeal nerve.

The blood-vessels of the head and neck have their commencement within the thorax. These are indicated in the discussion of the arch of the aorta. The vessels on the two sides, whether arteries or veins, differ considerably. —*See* Thorax.

A. The Arteries of the Head and Neck.

I. The common carotid artery appears in the neck, opposite the sterno-clavicular articulation. The course of the vessel is indicated by a line drawn from hence to the lobule of the ear. The artery in question, however, extends no higher in that line than the upper border of the thyroid cartilage. It gives off no branches, but ends by dividing into the internal and external carotids.

Relations.—The vessel is enclosed in a sheath common to it, the internal jugular vein, and the pneumogastric nerve. The artery has in *front*, skin, superficial fascia, platysma, descending branch of superficial cervical nerve, anterior jugular vein, deep fascia; sterno-mastoid, sterno-hyoid, sterno-thyroid, omo-hyoid muscles; descendens noni nerve; the sterno-mastoid branch of the superior-thyroid artery, and the middle thyroid vein; *behind*, longus colli and rectus capitis anticus major muscles; the inferior thyroid artery, and the sympathetic and recurrent laryngeal nerves; to the *outside*, the internal jugular vein; to the *inside*, the trachea and larynx, the œsophagus, and pharynx, and the thyroid gland.

II. The internal carotid artery runs in the line already indicated to the carotid canal in the petrous portion of the temporal bone. It there passes into the skull and breaks up to form the circle of Willis. (*See* Base of Brain.) The internal jugular vein accompanies the artery in the neck.

III. The external carotid artery commences at the upper border of the thyroid cartilage; it ends in the substance of the parotid gland, opposite the neck of the condyle of the lower jaw.

Between the artery and the surface, the following structures are found :—Skin, superficial fascia, platysma, deep fascia, parotid gland, facial and hypoglossal nerves; digastric and stylo-hyoid muscles; external jugular vein; and the facial, lingual and superior thyroid veins, on their way to the internal jugular vein.

Between the external and internal carotid arteries, are the parotid gland, the styloid process, the stylo-pharyngeus muscle, and the glosso-pharyngeal nerve.

The branches of the artery are :—

ANTERIOR GROUP.

1. Superior thyroid, giving off hyoid, superior laryngeal, crico-thyroid, and sterno-mastoid. The artery ends in the thyroid gland.

2. Lingual, giving off hyoid, dorsalis linguæ, sub-lingual, and ranine.

3. Facial.—This artery has two stages: (*a*) below the jaw, where it gives off ascending palatine, tonsillitic, sub-maxillary, and sub-mental; (*b*) on the face it gives off inferior labial, inferior coronary, superior coronary, lateralis nasi, and angular. The artery crosses the jaw two fingers' breadth in front of the angle.

POSTERIOR GROUP.

1. Occipital, giving off sterno-mastoid, auricular, meningeal, and arteria princeps cervicis.

2. Posterior auricular, giving off a stylo-mastoid branch to stylo-mastoid foramen.

ASCENDING GROUP.

1. The ascending pharyngeal.

TERMINAL GROUP.

1. The temporal artery ascends from opposite the neck of the condyle of the lower jaw, and passing in front of the ear, ends on a level with the highest point of the ear. It there divides into anterior and posterior branches. It gives off branches to the structures through which it passes.

2. The internal maxillary artery has three stages, according to its relations with the external pterygoid muscle: (*a*) From the commencement of the artery until it reaches the muscle, the branches are—tympanic, inferior dental (giving off the mylo-hyoid branch), middle meningeal, and small meningeal. (*b*) Whilst in contact with the muscle the artery gives off branches to the masseter, pterygoid, buccinator, and temporal muscles. (*c*) After the artery has gone through between the two heads of the muscle, it gets into the pterygo-maxillary fossa, and gives off the following—posterior superior dental, naso-palatine, descending or posterior palatine, Vidian, pharyngeal, and infra-orbital.

B. The chief VEINS in the neck are the internal and external jugular veins.

I. The external jugular vein commences opposite the neck of the condyle of the lower jaw in the substance of the parotid gland. It passes down the neck beneath the platysma, and crossing the sterno-mastoid, ends in the sub-

clavian vein. The branches joining it are:—The temporal and internal maxillary unite to form it. Before it leaves the parotid gland it is joined by the posterior auricular; as it leaves the gland it receives a communicating branch from the internal jugular. Halfway down the neck it is joined by the posterior external jugular vein; and at the lower part of the neck it is joined by the transversalis colli and humeri veins, and sometimes by the anterior jugular.

II. The internal jugular vein commences at the jugular foramen and ends in the innominate. It accompanies the internal and then the common carotid artery throughout their courses. The branches joining it are:—The inferior petrosal sinus, the facial, lingual, superior thyroid, occipital, ascending pharyngeal veins, and the communicating branch from the external jugular. (For the innominate veins, *see* Thorax.)

THE TONGUE

Is composed of voluntary muscular fibres, covered over with mucous membrane, and richly supplied with blood-vessels and nerves. The *muscles* are grouped into two sets:—

I. The extrinsic muscles are:—1. Genio-hyo-glossus. 2. Hyo-glossus. 3. Stylo-glossus. 4. Palato-glossus. 5. Pharyngeo-glossus—a bit of the superior constrictor. *Five* pairs in all.

II. The intrinsic muscles are:—1. Superficial lingualis, only one muscle. 2. Transverse lingualis, a pair. 3. Inferior lingualis, a pair. *Five* muscles in all.

The *blood-vessels* are the lingual vessels and their branches. The branches of the lingual artery are: Hyoid, dorsalis linguæ, sublingual, and ranine. *Five* in all.

The *nerves* are:—1. Gustatory; 2. Glosso-pharyngeal; 3. Hypoglossal; 4. Chorda tympani; and 5. Sympathetic. *Five* pairs in all.

The *papillæ* on the tongue are:—1. Simple all over the tongue. 2. Filiform over the centre of the dorsum. 3. Fungiform on the sides and tip. 4. Circumvallate at the junction of the posterior and middle third, arranged like the letter V. At the posterior third the glosso-pharyngeal nerve possesses taste-buds at its terminations.

THE MOUTH

Is lined throughout by mucous membrane, studded with glands, named labial, molar, and buccal, according to their situation. In the floor of the mouth lie the sub-lingual glands. They can be felt by the tip of the tongue on either side. They open by a number of ducts—ducts of Riviniani—into the mouth. They lie on the upper surface of the mylo-hyoid muscles. The duct of Wharton will be found to open on either side of the frænum; the duct of Stenson opposite the second molar tooth of the upper jaw.

The *gums* are composed of mucous membrane, sub-mucous tissue, and periosteum. The submucous tissue is strong and fibrous, and is tightly connected with the other layers.

The *teeth* are twenty in number in the child—milk teeth; thirty-two in number in adults—permanent teeth. The named parts of a tooth are the crown, the neck, and the fangs. The structures that compose a tooth are:—1. Dentine, forming the main mass of the tooth; it is composed of about twenty-eight parts of animal matter, the rest being bone salts. 2. Enamel, covering over the dentine, and forms the crown. It contains only two per cent. of animal matter. 3. Crusta petrosa, which resembles true bone, although not possessing Haversian canals; it lines the fangs of the teeth.

Within the tooth is a cavity containing the dental *pulp*. This consists of a fine network of connective tissue, interspersed in which are fine blood-vessels and nerves. The dental tubules derive nourishment therefrom.

The *milk teeth*, twenty in number, five at either side in either jaw, appear at the following months. Commencing at the central incisor at one side the average times are—7, 9, 18, 12, 24 months. They are called incisors, canine, and milk molars. The *permanent* teeth, thirty-two in number, eight at either side of either jaw, appear at the following years—commencing at the central incisor the average times are—7, 8, 11, 9, 10, 6, 12, 20 years. They are called—incisors (2), canine (1), pre-molars (2), molars (3). To write a dental formula, take the upper jaw teeth of one side as the numerator, and the lower jaw teeth of one side as the denominator, and we have $\frac{2}{2} - \frac{1}{1} - \frac{2}{2} - \frac{3}{3}$ in the adult human jaw.

The *Tonsil* lies between the anterior and posterior pillars of the fauces; it has the soft palate above, and the tongue below. Externally it rests on the superior constrictor muscle of the pharynx. The arteries supplying it are branches of :—1. The ascending pharyngeal; 2. The ascending palatine; 3. The descending palatine; 4. The tonsillitic; and 5. The dorsalis linguæ.

The *nerve* supplying it is the glosso-pharyngeal, which forms a circle around it—the circulus tonsillaris. The gland possesses a number of flask-shaped depressions or recesses, lined by epithelium and lymphoid structure, in large quantity.

The PHARYNX lies at the back of the nose and mouth, communicating with both, and with the œsophagus and larynx below. It reaches upwards to the base of the skull, and down to the commencement of the œsophagus; it measures about four and a half inches. The *muscles* forming it are—constrictors and elevators. The *constrictors* consist of three pairs of muscles—the superior, middle, and inferior. Roughly speaking, they arise in front: the inferior from the thyroid and cricoid cartilages, the middle from the hyoid bone, and the superior from the pterygo-maxillary ligament. They are all inserted into the raphe in the middle line behind, and reach as high as the pharyngeal spine on the occiput. The *elevators* are an external set, the stylo-pharyngeus, a pair of muscles; and an internal set, the salpingo-pharyngeus, round the mouth of the Eustachian tube. The muscles are chiefly supplied by the pharyngeal plexus of *nerves;* and pharyngeal *vessels* come from the ascending pharyngeal, the superior and inferior thyroid. In the pharynx the following *openings* are found, seven in all—two posterior nares, the openings of the two Eustachian tubes, and the openings of the mouth, larynx, and œsophagus.

The *soft palate* consists of mucous membrane, submucous tissue and a layer of muscles, with blood-vessels and nerves. It has two surfaces, anterior or inferior, and posterior or superior. The structure of which it is composed are, from behind forward:—1. Mucous membrane. 2. Sub-mucous tissue with glands. 3. Posterior fibres of the palato-pharyngeus. 4. Levator palati. 5. Azygos uvuli. 6. Anterior fibres of the palato-pharyngeus. 7. Tensor palati. 8. Palato-glossus. 9. Submucous tissue with glands. 10. Mucous membrane. The main mass of the palate is made up of sub-mucous tissue

with glands. The *blood-vessels* supplying the palate are: the ascending palatine, the descending palatine, and the ascending pharyngeal. The *nerves* are: a branch to the tensor-palati from the otic ganglion; branches from the descending palatine from Meckel's ganglion to the levator-palati and the azygos uvulæ. The palato-glossus is supplied by the hypoglossal, and the palato-pharyngeus by the pharyngeal plexus.

THE NOSE.

The NOSE consists of bony boundaries, with an anterior and posterior aperture. The bony *inlet* is cordiform, with the apex upwards; the *outlet* in the pharynx is quadrilateral, but divided into two by the vomer. Each aperture behind measures one inch from above downwards, and half an inch from side to side; these measurements necessarily indicate the size of a pad by which the posterior nares may be plugged.

The nose possesses roof, floor, and an outer and an inner wall. The *roof* is formed from before backwards by the nasal cartilages, the nasal bones, the frontal bone, the cribriform plates of the ethmoid, the body of the sphenoid, and the sphenoidal turbinated bones.

The *floor* is formed by the palate processes of the superior maxilla and palate bones.

The *outer* wall is formed by six bones. Three reach from roof to floor, the superior maxilla with its nasal process, the palate, and the internal pterygoid plate; three reach part of the way along the outer wall, the nasal, the lachrymal, and the ethmoid.

The *inner* wall, or septum, is formed from above downwards by the perpendicular plate of the ethmoid, the crest formed by the junction of nasal bones, the nasal spine of frontal, the vomer, the triangular cartilage, and the crest formed by the junction of the superior maxillary and palate bones.

On the outer walls of the nose are seen three *turbinated bones*. The lower is a separate bone, and reaches all the length of the nose; the other two are processes from the ethmoid bone, and reach only partially along the nose. They divide the outer wall into three MEATUSES, the superior, middle, and inferior. Each meatus is below its corresponding turbinated bone.

Into the *lower* meatus the nasal duct opens; into

the *middle* the infundibulum, and the antrum of Highmore; into the *upper*, the ethmoidal cells, sphenoidal cells, and naso-palatine foramen. The infundibulum transmits air from the frontal sinuses and anterior ethmoidal cells. The nose is lined throughout by the Schneiderian membrane, which consists of the mucous and submucous tissue firmly blended with periosteum. The *nerves* found in the nose are:—in the upper part the *olfactory* nerve, found distributed wherever the ethmoid bone presents a surface to the nose. The other nerves are found chiefly at the four angles; at the anterior superior part is found the *nasal* twig from the fifth; at the anterior inferior part branches from the anterior *dental*; posteriorly and inferiorly, branches from the *descending palatine*; posteriorly and superiorly, *naso-palatine* nerves. The last-mentioned group sends one branch down the side of the septum towards the anterior palatine foramen, called the nerve of Cotunnius. The *blood-vessels* of the nose enter the foramina with the nerves, they are chiefly supplied from the internal maxillary, and one, the artery to the septum, comes from the anterior coronary in the upper lip.

THE THORAX.

The thorax is an all-important region to the physician, and but little less so to the surgeon. There is scarcely an inch of it that it is not essential to know well, and to be thoroughly familiar with. The area of the thorax on the surface of the body is much greater than the internal boundaries give out. This is accounted for by the upward arching of the diaphragm, allowing the liver, stomach, and spleen to be placed under cover of the ribs; and as the ribs are considered the limits of the thorax on the surface, so it is that its superficial area exceeds the extent of the actual cavity. The *boundaries* are:—

1. Anteriorly. Sternum, intercostal cartilages, and intercostal spaces, filled up by internal intercostal muscles and fascia.

2. Laterally. Ribs and intercostal spaces filled up by the external and internal intercostal muscles, vessels, nerves, and fascia.

3. Posteriorly. Bodies of dorsal vertebræ, intervertebral substances, anterior common ligament, heads, necks, and angles of the ribs, intercostal spaces filled up by external intercostal muscles, &c.

4. Inlet, or upper limit. Upper end of sternum, cartilage of first rib, inner border of first rib, neck and head of first rib, and first dorsal vertebra.

5. The base or inferior limit is formed by the *diaphragm.*

The diaphragm, or midriff, is a partition placed obliquely transverse between the thorax and abdomen. It is musculo-tendinous in character, and is the main muscle of inspiration. The points from which it arises are:—The xiphoid cartilage; inner aspect of the cartilages of the six lower ribs, interdigitating with transversalis muscle; ligamentum arcuatum externum, as it stretches over quadratus lumborum; ligamentum arcuatum internum, as it stretches over psoas muscle; and from the crura. The *crura* of the diaphragm are two in number, right and left; the right is the *longer*, reaching as low down as the upper border of the fourth lumbar, the left, as low as the upper border of the third. *The crura* are tendinous at their origins, and meet each other across the middle line, enclosing a tendinous arch, beneath which passes the aorta. From their outer borders muscular fibres arise, which pass out into the diaphragm, and muscular fibres pass inwards from either crus and cross in the middle line. The diaphragm is muscular at the sides, but aponeurotic in the centre. The muscular fibres all converge to the central tendinous leaflet, a trefoil, or three-bladed piece of aponeurosis, spread out in the centre of the diaphragm. The blades are scarcely equal in size, the right being the largest, the left the smallest.

Relations. — *Above*—The heart and pericardium, attached to the central tendinous leaflet; on either side the lungs and pleuræ. *Below*—The peritoneum, and the following viscera—the liver mainly on the right side, the stomach mainly in the middle line, the spleen on the left, the kidneys and supra-renal capsules at the lower and back part, and the pancreas crossing the crura.

Nervous supply.—The phrenic nerves.

Arterial supply.—1. The comes nervi phrenici, or superior phrenic artery, from the internal mammary artery. 2. The musculo-phrenic, from the internal mammary; this artery runs along the upper surface of the diaphragm, close to its origin from the costal cartilages. 3. A few of the lower aortic intercostals. 4. The diaphragmatic or inferior phrenic, from the abdominal aorta.

Action.—The descent of the diaphragm increases the area within the chest-wall, and allows the air to enter and expand the lungs. The sides of the diaphragm are the only parts that move; the centre part, aponeurotic, is retained in its place by the fibrous pericardium. Owing to the oblique attachment of the diaphragm, the direction of its descent is not straight downwards, but downwards and forwards. Some of the viscera below the diaphragm will necessarily be affected by its descent—viz., the liver, stomach, and spleen. These viscera are under cover of the ribs, and in contact with the diaphragm, for the purpose of receiving the stimulus and pressure from the diaphragm necessary for the performance of their functions.

In the diaphragm exist *openings* and *fissures.*

The *openings* are three in number: 1. The most anterior is the orifice for the inferior vena cava, an aponeurotic opening, a little to the right of middle line; it is *quadrilateral* in shape. 2. The orifice for the œsophagus is a muscular opening, which transmits the œsophagus, the right and left pneumogastric nerves—the left in front, the right behind, and branches of communication of arteries between the gastric and œsophageal; it is *elliptical* in shape, the long axis of the ellipse extending in an anterio-posterior direction. 3. The aortic orifice, an osseous tendinous opening, having the vertebræ behind and the crura on either side. It transmits the aorta, vena azygos major, thoracic duct, and sympathetic nerves; it is *oblique* in shape.

The *fissures* or slits in the crura are for the passage of the greater and sometimes the lesser splanchnic nerves, and it may be the vena azygos minor in the left crus.

The contents of the thorax are arranged in mediastina, anterior, middle and posterior. These spaces are between the two pleural sacs in the middle line, and reach from the upper part of the thorax right down to the diaphragm. As the upper limit is somewhat indefinite, it is proposed to describe a fourth or superior mediastina or a region called the root of the neck. This arrangement will ensure all the contents of the chest being included in any enumeration.

The pleuræ are best understood by sketching the thoracic viscera in position and then filling in the reflexions.

It will be found that, commencing from the back of the sternum and passing outwards, the pleura passes on the inner surface of the chest wall, round the angles, necks, and heads of the ribs, forming the parietal layer of the pleura. It then gets on to the sides of the bodies of the vertebræ, and hence to the back of the pericardium. After leaving the pericardium, it gets on to the back part of the root of the lung, along the posterior part of the inner surface of the lung, round the posterior border, along the outer convex surface, round the sharp anterior border, then along the anterior part of the inner surface of the lung, on to the anterior part of the root of the lung, and, again touching the pericardium, passes up towards the sternum to the point at which we commenced. The pleural sacs project above the upper aperture of the thorax about one and a half inches, and reach right down to the diaphragm. Between the two pleural sacs spaces are left in the median line, called *mediastina.*

1. The *anterior* mediastinum is bounded in *front* by the back of the sternum, the costal cartilages, and the fascia covering the spaces between them, *behind* by the pericardium, and on either *side* by the two pleuræ. Its *contents* are—the origins of the sterno-hyoid and sterno-thyroid muscles, the triangularis sterni muscles, the lower part of the left internal mammary artery, the remains of the thymus gland, lymphatics from the upper surface of the diaphragm, and loose areolar tissue, with a few fine blood-vessels. The *rationale* of all the contents is easily understood, with the exception of the left mammary artery. All the other structures mentioned are close to the middle line; but, as the internal mammary arteries pass down on either side behind the costal cartilages, the pleura overlaps the vessels, except at the lower part of the left vessel, where, owing to the left lung being pushed to the left by the heart, the artery is exposed in the mediastinum.

2. The *middle* mediastinum has in *front* the anterior, and *behind* the posterior mediastinum. On either *side* are the two pleuræ. The *contents* are the pericardium, containing the heart and great vessels, and the two phrenic nerves.

3. The *posterior* mediastinum is bounded in *front* by the pericardium, *behind* by the vertebral column and the anterior common ligament, laterally by the pleural sacs.

The *contents* are—the œsophagus going down, the thoracic duct coming up; the aorta going down, and the vena azygos major coming up. Along with the œsophagus are the two pneumogastric nerves; and at the lower part, on the sides of the aorta, the great splanchnic nerves.

4. The *superior* mediastinum, or the root of the neck, comprehends the upper part of the previous three. It is bounded by a line drawn from below the first portion of the sternum—the manubrium—just where the second rib joins it, back to the third dorsal vertebræ. Most anteriorly in this space—*i.e.*, immediately behind the sternum, are placed—

1. An anterior *muscular* plane, consisting of the origins of the sterno-hyoid, and sterno-thyroid muscles.
2. A *venous* plane, consisting of the innominate veins uniting to form the superior vena cava.
3. A *nervous* plane, consisting of the pneumogastric, phrenic, and cardiac branches of the sympathetic of the left side crossing the arch of the aorta.
4. The *arterial* plane, the arch of the aorta, and the great arteries given off from it—viz., the innominate, left carotid, and left subclavian.
5. The *respiratory* plane, the trachea.
6. The *food* plane, the œsophagus.
7. A posterior *muscular* plane, the longus colli muscle, as it arises from the upper dorsal vertebræ.

THE HEART.

The Pericardium.—On opening the pericardium it will be found to consist of a fibrous sac, lined internally by a serous layer. The *fibrous pericardium* is of use to protect the heart, and to keep it fixed in its place. It is attached *above* to the aorta at the junction of the first and second stages, and above that it is continuous with the deep cervical fascia; *below* it is firmly adherent to the diaphragm around the central leaflet of the aponeurosis; on *either side* of the pericardium are the two pleural sacs and phrenic nerves; in *front* the anterior mediastinum, and *behind* the œsophagus as it lies in the posterior mediastinum.

The *serous pericardium* lines the inner surface of the fibrous, and touches the central leaflet of the

aponeurosis of the diaphragm. At the root of the heart it meets the great vessels passing to and fro, and is conducted by them on to the heart substance, which it completely encloses.

At the root of the heart eight vessels are found, and the serous pericardium forms reflections over each, but as the pulmonary artery and aorta are enclosed in one, there are only seven reflections of pericardium. On opening the pericardium from the front the following parts are seen :—All *four* cavities of the heart, but in unequal amounts, and *three* great vessels—seven structures in all. The anterior surface presents for the most part the right ventricle; there is also to be seen the right auricular appendix and a bit of the right auricle, the left ventricle forming simply the apex, and the tip of the left auricular appendix. The three vessels seen are, from right to left, the superior vena cava, the aorta, and the pulmonary artery.

The HEART is an involuntary muscle, having its fibres so arranged as to enclose cavities in which the blood circulates, and by which the blood is driven onwards in its course. The arrangement of the muscular fibres in the heart are very complex. In the ventricle the planes of fibres are seven; the outer plane is continuous with the inner, the plane immediately beneath the outer continuous with that immediately beneath the inner, and so for the third. In the centre is the seventh or odd layer. Over the auricles two layers of muscular fibres are found.

The line of attachment for the muscular fibres is all around the auriculo-ventricular groove. Here is a dense mass of fibrous and tendinous tissue, which is in some animals even bony. The surface of the heart is marked by *grooves*. All around the heart is a deep groove—the auriculo-ventricular—between the auricles above and the ventricles below. Down the front and back of the heart runs the ventricular groove, and upwards the auricular, between the ventricles and auricles respectively. The vessels run mainly in these channels. The *arteries* are the two coronary. The *right* coronary passes forwards from the aorta between the pulmonary artery and the right auricular appendix, and runs along the right auriculo-ventricular groove to the back of the heart, where it descends between the two ventricles. The *left* coronary passes forwards from the aorta between the pul-

monary artery and the left auricular appendix, and gives off a large branch to the left auriculo-ventricular groove, whilst the trunk of the artery descends in the groove between the ventricles in front. These *arteries* have not been proved to anastomose.

The *veins* of the heart are called *cardiac.* There are *four* sets :—

1. The anterior or great cardiac. This vessel commences at the apex of the heart, runs upwards between the ventricles in front, turns back between the left auricle and ventricle, and ends behind in the coronary sinus.

2. The posterior cardiac runs from the apex of the heart upwards between the ventricles behind and ends in the coronary sinus.

3. The veins from the surface of the right ventricle run directly into the right auricle.

4. The veins returning from the substance of the right auricle open directly into the auricle by the foramina Thebesii.

The *coronary sinus* is a channel about one inch long, which lies between the auricles and ventricles behind. It is imbedded in the heart substance, having muscular fibres from the auricles crossing it. It has valves at all the openings into it—viz., between the junction of the great cardiac and posterior cardiac veins, and at the opening into the heart. The sinus opens at the posterior part of the right ventricle low down on its left side. The valve guarding it is called the *valve of Thebesius.*

Microscopically, the heart fibres consist of muscular cells, which are nucleated, striated, and branched. There is no sarcolemma around the fibres, which anastomose freely, forming fine plexuses.

The *nervous* supply of the heart is complex, there being ganglia within the heart substance, and cardiac plexuses without. The ganglia preside over the rhythm of the contractions of the heart; but to the cardiac plexuses, superficial and deep, come nerves from the pneumogastric and sympathetic. The former act by inhibiting—*i.e.*, slowing—the latter by accelerating, the heart's action. The balance of the two is necessary for the regular action of the heart.

To ascertain the *position of the heart,* hold the apex forwards, and the base backwards; the difference in

thickness of the two ventricles, will at once tell the right from the thicker left ventricle. The posterior or inferior surface will be seen to be flat, owing to its resting on the diaphragm, and the anterior or superior surface will be found to be convex. Now proceed to open and examine the heart. To study the anatomical parts one wants to interfere as little as possible with the openings, &c.; so that there is a little difference between the method of the examination of a heart for anatomical and pathological purposes. Here then is described the anatomical method.

1. The *right auricle.*—First examine the openings—viz., the superior and inferior venæ cavæ: the superior opens by an aperture about $\frac{3}{4}$ inch in diameter, into the highest point of the right auricle; the inferior has an opening 1 inch in diameter, situated at the lower and back part of the auricle. Now open the auricles by cutting with a scissors from the inferior caval opening forwards to the auricular appendix. This will disturb the relations of the parts less than any other incision.

There are four sets of *inlets* into the right auricle:—the superior vena cava; the inferior vena cava; the coronary sinus; and the foramina Thebesii. The positions of all these have been already described. One large aperture, the *outlet*, allows the blood to escape into the ventricle—the *right auriculo-ventricular.* Into this, one ought to pass the fingers to gauge its size; usually the tips of three of the fingers fill the aperture completely. The points further to be noted are:—The *tubercle of Lower* on the right wall, which is simply a thickened part of the heart substance; the *musculi-pectinati* on the anterior wall, and in the auricular appendix; the *annulus* and *fossa ovalis* on the left wall. Covering over the coronary sinus is the *valve of Thebesius*, and stretching from the anterior part of the inferior vena cava to the anterior part of the fossa ovalis, are to be seen the remains of the *Eustachian valve*; this valve is fully developed in the fœtus, where it directs the blood from the inferior vena cava into the *foramen ovale*, which exists in the septum between the auricles. At birth the blood ceases to pass in that direction, the foramen gets closed by a septum, and the valve becomes rudimentary.

2. The *right ventricle.*—The blood passes through the right auriculo-ventricular opening, from the auricle into the ventricle. In the right ventricle are seen *columnæ carneæ*, some of which are mere bulgings on the walls,

whilst others are attached at their ends, but are free in the centre of their course. The *musculi papillares* are the small muscular cones, to which the *chordæ tendineæ* are attached. The chordæ tendineæ are round fibrous cords which pass from the muscular papillæ to the valves; they prevent the valves being driven back into the auricle when the blood shuts them. VALVES.—The *tricuspid* or right auriculo-ventricular valve consists of three valves or cusps. The valves hang towards the ventricle, and consist of reflections of the endocardium, strengthened by the insertion of the chordæ tendineæ. The valves are placed so that one cusp intervenes between the auriculo-ventricular opening and the opening of the pulmonary artery —the *pulmonary* cusp lying anteriorly and to the left. A second cusp is attached opposite the right wall of the ventricle—the *parietal cusp*, lying anteriorly and to the right. A third cusp is attached opposite the septum—the *septal cusp*, lying posteriorly and to the left towards the ventricular septum. The contraction of the ventricle shuts the auriculo-ventricular valves, and sends the blood along the pulmonary artery to the lungs. To prevent the back flow, *valves* are placed at the root of the *pulmonary artery;* these are three in number and are semilunar in shape. These are composed of reflections of endocardium, with between them fibrous tissue to give consistence. The fibrous tissue is arranged in the following way :—the lower part of the valve is occupied by a layer of fibrous tissue which reaches the centre of the margin of the valve, as a hard round nodule, called the *corpus aurantii*, but which falls short of the lateral borders, leaving a semilunar edge, the *lunated* spot, formed only by endocardial tissue. The valves, when they close, meet at the edges of the fibrous tissue. Behind the cusp is a space called the *sinus of Valsalva*, in which the blood collects previous to the closure of the valve. The blood now passes to the lungs by the pulmonary arteries, and returns by the four pulmonary veins to the left auricle.

3. The *left auricle* is placed so that only the tip of the auricular appendix is to be seen on the anterior aspect of the heart. The *inlets* are—*four pulmonary* veins, two on the right and two on the left; no valves cover their apertures. The *outlet* is the *left auriculo-ventricular* opening, capable of admitting two finger-tips easily. In the auricle besides the openings nothing except the musculi-pectinati are to be seen. These prominences

are confined to the auricular appendix, and are not spread across the anterior wall as on the right side.

4. The *left ventricle.*—In this cavity columnæ carneæ, musculi papillares, and chordæ tendineæ are present as in the right ventricle. The *inlet,* the left auriculo-ventricular opening, is guarded by the bicuspid or mitral valve; the *outlet* into the aorta is guarded by semilunar valves as in the pulmonary artery. VALVES.—The two cusps of the *mitral* valve are so arranged that one is placed between the auriculo-ventricular opening and the aortic orifice lying anteriorly and to the right—the *aortic cusp;* the other against the left wall of the heart lying posteriorly and to the left—the *parietal cusp.* The *semi-lunar* aortic valves, *three* in number, have behind them the sinuses of Valsalva, and from the upper part of the two anterior sinuses the right and left coronary arteries arise. The position of the semilunar valves is, one anterior and to the right, another anterior and to the left, and the third posterior. Structure of left valves same as right.

THE ARTERIES OF THE THORAX.—The *arch of the aorta* is divided for convenience of description into three stages.

1. The *first stage* commences at the left ventricle, corresponding on the surface of the chest to the spot where the third left costal cartilage joins the sternum. From hence it passes upwards, forwards, and to the right, coming up as high as the second costal cartilage on the right side. It is enclosed within the fibrous pericardium, so that when it ruptures blood escapes into the pericardium. The relations are—in *front,* the right auricular appendix, the pulmonary artery, the pericardium; and in a plane anterior to these, loose areolar tissue containing the remains of the thymus gland; *behind,* the right division of the pulmonary artery; *to the right,* the superior vena cava and right auricle; *to the left,* the trunk of the pulmonary artery.

2. The *second stage* passes upwards, backwards, and to the left in the first part of its course, and then directly backwards, reaching from the second costal cartilage on the right side to the left side of the fourth dorsal vertebra. Its highest point is opposite the middle of the manubrium sterni. The relations are—*in front,* sternum, sterno-hyoid and sterno-thyroid muscles, left lung and pleura, the trunks of the phrenic and pneumogastric nerves, the cardiac branches of the pneumogastric and sympathetic nerves, and the left superior intercostal vein;

behind, trachea, œsophagus, thoracic duct, and the recurrent laryngeal nerve; *above*, the vessels given off, and the left innominate vein; *below*, the bifurcation of the pulmonary artery, the ductus arteriosus, the root of the left lung, the cardiac plexuses of nerves, and the left recurrent laryngeal nerve.

3. The *third stage* passes along the left side of the vertebræ, from the fourth to the sixth, towards the middle line. It has, in *front*, the roof of the left lung; *behind*, the vertebral column; to *the left*, the left lung and pleura; and to *the right*, the œsophagus and thoracic duct.

The *thoracic aorta below the arch* passes along the side of the vertebræ until it reaches the osseo-tendinous opening in the diaphragm opposite the twelth dorsal vertebræ. It has, in front, the pericardium, and at the lower part, the œsophagus; *behind*, the vertebral columns and vena azygos minor and splanchnic nerves; to *the left*, the left lung and pleura; and to the *right*, the œsophagus, thoracic duct, vena azygos major, and right lung.

The *branches* of the aorta within the thorax are:—

1. The right and left coronary (*see* Heart).

2. The innominate artery. This vessel commences opposite the middle of the manubrium sterni, at the highest part of the arch of the aorta, and extends upwards and to the right, as far as the right sterno-clavicular articulation. It there divides into right subclavian and right common carotid arteries. In length it is one inch, to one inch-and-a-half. It has, in *front*, the left innominate vein and the top of the sternum; *behind*, the trachea; to the *left*, the left common carotid artery, and at its upper part the trachea; and to *the right*, the innominate vein.

3. The left common carotid arises close to the preceding and passes upwards to the neck (*see* Carotid Arteries).

4. The left subclavian, larger than the preceding, arises about half an inch beyond the preceding, and reaches the lower part of the neck (*see* Subclavian Arteries).

5. Two bronchial arteries, an upper and lower, arise behind the roof of left lung. The upper vessel divides into two branches, one going to the right, the other to the left lung; the lower artery goes wholly to the left lung.

6. Five or six œsophageal branches.

7. Pericardial branches.

8. Ten pairs of aortic intercostals supplying the intercostal spaces below the first. Each vessel passes along the lower border of a rib, under cover of a lip of bone

which protects it until half-way forward, where the vessel divides into two, one branch running along the upper, the other the lower border of the intercostal spaces. In front—the terminal branches anastomose with the anterior intercostals from the internal mammary.

The other arteries in the thorax are the following :—

The *internal mammary artery* comes off from the first stage of the subclavian. It immediately passes into the thorax, having the phrenic nerve on its inner side, and getting between the cartilages of the ribs and the pleura, is conducted down to the diaphragm. It is not included in the anterior mediastinum, except at the lower part of the left artery as already explained (*see* Mediastina).

The branches are :—1. Comes nervi phrenici, or superior diaphragmatic. This is a fine twig which accompanies the phrenic nerve. 2. Sternal. 3. Mediastinal. 4. Perforating vessels which pass through the intercostal spaces and appear on the side of the sternum. 5. Anterior intercostals, two to each space, run out between the intercostal muscles and meet the anterior terminations of the aortic intercostals. *Terminal* branches :—6. The musculo-phrenic artery runs outwards along the upper surface of the diaphragm, close to the costal cartilage; it there meets the branches of the intercostal arteries.—7. The superior epigastric passes down on the side of the xiphoid cartilage into the substance of the rectus muscle where it meets and anastomoses with the deep epigastric from the external iliac artery.

The *superior intercostal artery* comes from the first stage of the subclavian, and supplies the inner aspect of the upper intercostal spaces. The arteria princeps cervicis comes off from it.

The *pulmonary artery* arises from the upper part, the conus arteriosus of the right ventricle, and after a course of two inches divides into right and left branches. Its course is upwards, backwards, and to the left. Its relations are :—in front, the pericardium; behind, the aorta; to the right, the aorta and the right auricle; to the left, the left auricular appendix. It is enclosed in the same sheath of serous tissue as the aorta, and the two coronary arteries pass forwards on either side. The root is guarded by valves already described (*see* p. 54).

The pulmonary artery bifurcates in the hollow of the aorta arch below the ending of the trachea. The *right* branch, the longer, passes behind the aorta and superior vena cava, and in front of the right bronchus, to the root

of the right lung. The *left* passes over the descending aorta into the root of the left lung. Connecting the left pulmonary artery to the aorta is the *ductus arteriosus*, a fibrous cord in the adult, but which in the fœtus completed the circulation, by allowing the blood from the superior vena cava, right auricle, right ventricle, and pulmonary artery to pass through into the aorta (*see* Fœtal Circulation).

The *pulmonary veins*, four in number, two from each lung, have almost exactly the same relations as the arteries. The *right* veins emerge from the root of the right lung, pass behind the superior vena cava, aorta, and pulmonary artery into the left auricle; the *left* descend in front of the aorta to the left auricle. No valves are found in these veins.

The VEINS in the thorax consist of two sets, those of the parietes and those of the cavity.

A. The veins of the *parietes* are :—

1. The *vena azygos major.* This vessel commences by the upper two lumbar veins on the right side, and by a communication with the inferior vena cava. It passes up, generally through the aortic orifice, and getting into the posterior mediastinum, ascends on the right of the aorta, arches over the top of the root of the right lung, and opens into the superior vena cava. It receives in the thorax the veins corresponding to the right aortic intercostals, the right superior intercostal vein, the right bronchial, and opposite the seventh dorsal vertebra the vena azygos minor.

2. The *vena azygos minor* commences by the upper two left lumbar veins, passes up through the left crus of the diaphragm, receives the lower six left intercostal veins, and crosses at the seventh dorsal to join the major.

3. The *left superior intercostal vein* drains the upper part of the left chest wall, passes over the anterior aspect of the arch of the aorta, to join the left innominate vein.

4. The *right superior intercostal* is a small vessel that joins the vena azygos major or the right innominate.

5. The *vena azygos minor superior* is an occasional vessel, which, formed by the junction of the fourth and fifth left intercostal veins, passes down to join the major.

B. The veins of the *cavity*.

The internal jugular and subclavian veins meet behind the inner end of the clavicle, and form the right and left innominate veins respectively.

The *right innominate vein* passes from behind the

clavicle, down through the superior aperture of the thorax, to join the left innominate, at the first right intercostal space. In length it measures about $1\frac{1}{2}$ inches. Its relations are—*in front*, the chest wall; *behind*, the right pneumogastric nerve; *to the left*, the innominate artery; and *to the right*, the right lung and pleura.

The *left innominate vein* forms behind the left clavicle, enters the superior aperture of the thorax, crosses the aorta and great vessels as they are given off therefrom, and joins with the right innominate to form the superior vena cava. It is three inches long.

The *superior vena cava* commences behind the inner end of the first intercostal space, and passes downwards through the fibrous pericardium into the right auricle. It is $1\frac{3}{4}$ inches in length. The relations are:—in front, the sternum and pericardium; behind, the root of the right lung; to the left, the aorta; and to the right, the right lung and pleura. It is joined, just before it pierces the pericardium, by the vena azygos major.

The *inferior vena cava* has no course in the thorax.

The NERVES of the thorax are:—

1. The phrenic nerves, right and left, arise in the neck, from the anterior primary divisions of the third and fourth cervical nerves. Occasionally branches from the fifth also join in their formation. The nerves descend on the anterior scalene muscles, cross the subclavian artery at the junction of its first and second stage, and keeping within the internal mammary artery, reach the thorax. The nerves are found in the thorax in the middle mediastinum, in front of the root of either lung, and on the side of the pericardium. On reaching the diaphragm the nerves pierce it, and are finally distributed on its under surface. The left nerve is the longer on account of its having to cross the aorta; the bulging of the pericardium and heart to the left; the diaphragm being lower on the left than on the right side.

2. The pneumogastric nerves, right and left, enter the thorax between the venous and arterial planes at the root of the neck. The right, after crossing the first stage of the subclavian, gives off its recurrent laryngeal branch, and getting behind the innominate vein, goes down alongside of the trachea to the back of the root of the right lung. On the left side the nerve descends between the left common carotid and the left subclavian arteries and behind the left innominate vein. It then crosses the

aortic arch, gives off its recurrent laryngeal nerve, and gets behind the root of the left lung. *At the root* of the lungs the pneumogastric nerves give off branches to join a plexus in front of the root of both lungs, *anterior pulmonary plexuses*, and then break up to form, along with the sympathetic, the *posterior pulmonary plexuses*. From the lower part of the plexus a few branches of the nerve emerge, and get on to the œsophagus. Here they form the *plexus gulæ*, and, collecting into single trunks, pass through the œsophageal opening, the left in front, the right behind.

The only *recurrent laryngeal* nerve in the thorax is the left, the right coming off above the superior aperture. The left nerve passes beneath the aortic arch, hooks round the remains of the ductus arteriosus, ascends between the trachea and œsophagus, supplying both, and then disappears within the larynx.

3. The sympathetic nerve (*see* Sympathetic System).

The Œsophagus is the muscular tube which extends from the pharynx to the stomach. It commences in the neck, opposite the fifth cervical vertebra, and, after a course of nine inches, ends opposite the ninth dorsal by piercing the diaphragm. It has a cervical and thoracic portion. The relations in the *neck* are:—in front, the trachea; behind, the vertebral column; on the left the thoracic duct; on the right and left the common carotid arteries, and the recurrent laryngeal nerves. In the *thorax* the œsophagus has in front the trachea at the upper part, and the pericardium below; behind, the thoracic duct, the vertebral column, and the aorta below; to the right, the vena azygos major and the right lung: to the left, the aorta and the left lung. The œsophagus is not a straight tube, but has two sets of *curvatures*:—the *antero-posterior*, in which it first curves forwards, then backwards, and then forwards below, to get through the diaphragmatic opening; the other *lateral*, in which it will be found after starting in the middle line, to curve first to the left, then back to the middle line, then again to the left to get through the diaphragm. At the root of the neck the œsophagus lies well to the left of the trachea.

The *structure* of the œsophagus is:—externally a layer of fibrous tissue, beneath which is a muscular layer consisting of an external longitudinal and an internal

circular set of fibres. Within these a submucous layer, and most internally a mucous membrane covered with squamous epithelium. The muscular fibres are striated at the upper part, but non-striated below. Their action is involuntary. The *arteries* supplying the œsophagus are branches from the inferior thyroids, four or five branches from the thoracic aorta, and a branch from the gastric artery of the stomach. The veins correspond. The *nerves* supplying the upper end are the inferior or recurrent laryngeal and below the plexus gulæ formed by the pneumogastric.

The Thoracic Duct is the means by which the lymph gets into the venous blood. It commences opposite the second lumbar vertebra by the junction of four or five large lymphatic trunks. It passes up through the aortic orifice in the diaphragm, ascends in the posterior mediastinum until it reaches the fourth dorsal vertebra, where it crosses, and ascends to the left of the œsophagus. It emerges at the top of the thorax on the left side, and reaching the level of the sixth cervical vertebra, arches forwards, over the subclavian artery, and in front of the anterior scalene, to end at the junction of the left internal jugular and subclavian veins. The coats are:—an external, consisting of fibrous tissue and with elastic tissue intermixed; a middle possessing circular muscular fibres, with fibrous and elastic tissues intermixed; and an internal, of oblique elastic fibres with a serous lining inside. The internal wall is dotted with valves, which give rise to the varicose appearance of the outline of the thoracic duct. Its vascular supply is from the vessels in the neighbourhood. Its length is eighteen inches. Its relations are:—in the *abdomen* it is situated behind and to the right of the aorta, and between the two crura of the diaphragm; in the *thorax* it has—in front, the œsophagus; behind, the right aortic intercostals and the vertebral column; to the left, the aorta; to the right the vena azygos major. These are the relations as high as the fourth dorsal vertebra; but above that it ascends between the œsophagus and the trachea.

THE LARYNX.

The organ concerned in the production of the voice consists:—of cartilaginous walls united together by liga-

ments, of vocal cords, of muscles necessary for the modulation of the voice, and of vessels and nerves to supply the various parts.

The *cartilages* are :—the *thyroid* cartilage, shaped like a shield, closed in front but open behind; the *upper border* is wavy in its outline, and behind is continued up to form the *two superior cornua.* The *lower border* is nearly straight, but behind the two inferior cornua project downwards to articulate with the cricoid cartilage. To the cartilage various ligaments and muscles are attached.

The *cricoid* cartilage is in shape like to a signet ring; the narrow band of the ring in front, the thickened part or signet behind. On the top of the signet are placed two facets for articulation with the arytænoid cartilages. On the sides are two facets for articulation with the inferior cornua of the thyroid cartilage. To it are attached various ligaments and muscles.

The *arytænoid* cartilages, situated on the top of the back part of the cricoid, are two *pyramidal* masses with a facet at their bases, for articulation with the cricoid. They possess an apex, a base, three surfaces and three angles. The surfaces are internal, anterior, and posterior. The angles are anterior, posterior, and external.

The *cuneiform* cartilages, two oblong streaks of fibro-cartilage, are contained in the arytæno-epiglottidean folds. Small nodules, two or three in number, the *cartilages of Santorini,* are found near the apex of the arytænoids.

The *ligaments* (membranes of the larynx) are :—

The thyroid-hyoid, crico-thyroid, and the capsular ligaments uniting the various articular surfaces. These names explain their attachments. The crico-thyroid membrane is attached below to the cricoid cartilage all the way round, but above forms the true vocal cords.

The *muscles* of the larynx consist of two sets, the extrinsic and the intrinsic.

The *extrinsic* muscles are those which arise beyond the precincts of the larynx, and are inserted into one of its cartilages; they are :—The sterno-thyroids; the thyro-hyoids; the stylo-pharyngei; and the inferior constrictors of the pharynx.

The *intrinsic* muscles :—

1. The *crico-thyroids* arise from the outer side of the cricoid cartilage, and are inserted into the lower border of the thyroid cartilage. They *tense* the vocal cords by pulling forward the thyroid cartilage.

2. The *thyro-arytœnoidei* passing from the anterior surfaces of the arytænoid cartilages run parallel to the true vocal cords, and are inserted into the thyroid cartilage. They *relax* the vocal cords by approximating the thyroid and arytænoid cartilages.

3. The *crico-arytœnoidei postici* arise from depressions on the back of the cricoid, and are inserted into the external angles of the arytænoid cartilages. They *widen* the chink between the vocal cords, by rotating outwards the arytænoid cartilage.

4. The *crico-arytœnoidei laterales* arise from the upper border of the cricoid cartilage, and pass backwards to be inserted into the external angle of the arytænoid cartilages. They *narrow* the chink between the vocal cords by rotating inwards the arytænoid cartilages.

5. The *arytœnoideus* muscle passes from the posterior surface of one arytænoid cartilage to the other. It *approximates* the arytænoid cartilages, and so changes the shape of the chink between the vocal cords.

The *arteries* which supply the larynx are, the laryngeal branches of the *superior* and *inferior thyroid*. The former pass through the thyro-hyoid membrane; the later pass beneath the inferior constrictor muscle, and between the inferior cornua of the thyroid, and the sides of the cricoid cartilages. The vessels anastomose freely in the larynx. The *veins* correspond to the arteries.

The *nerves* are—the *superior* and *inferior* laryngeals. They enter with the vessels. The superior laryngeals, before they enter, give off the *external laryngeals* to supply the *crico-thyroid* muscles. The parts of the nerves which enter the larynx supply the mucous membrane, as low as the vocal cords with *sensation*. The inferior or recurrent laryngeal nerves *supply* all the other *muscles* of the larynx with motion, and the mucous membrane below the vocal cords with sensation.

The *aperture into the larynx* from the pharynx is bounded, in front by the epiglottis, and on either side by the arytæno-epiglottidean folds of the mucous membrane. It is triangular in shape, with its base forwards, and its apex backwards at the arytænoid cartilages.

The *rima glottidis*, or the chink of the glottis, is situated between the true vocal cords. It is triangular in shape, with its base backwards at the arytænoideus muscle, and its apex forwards at the thyroid cartilage; the sides are formed by the true vocal cords, and the arytænoid car-

tilages. The *vocal cords* are known as the true and the false. The *true* are formed by elastic tissue continuous with the upper border of the crico-thyroid membrane, and are quite straight; the *false*, above the true, are simply arched reflections of the mucous membrane. Between the false and true cords is the recess called the *ventricle* of the larynx; this again leads by a small aperture into the *saccule of the larynx*, a small saccular dilatation lined by mucous glands, which serve to keep the vocal cords moist. Acting on the saccule is the *compressor sacculus laryngis* muscle, a part of the thyro-arytænoid muscle which serves to empty the saccule of its contents. The length of the rima is 11-12ths of an inch.

THE TRACHEA, BRONCHI, AND LUNGS.

The TRACHEA is a tube 4½ inches long, kept open by cartilaginous rings so as to allow of the passage of air.

It commences opposite the fifth cervical vertebra, and ends opposite the third dorsal. The commencement is easily made out by feeling for the cricoid cartilage. The relations vary according as to whether the cervical or thoracic portion is considered. The *cervical* portion has:—in front, the skin, superficial fascia, deep fascia, occasionally a transverse branch uniting the anterior jugular veins, the isthmus of the thyroid gland opposite the 3rd and 4th rings, and the fascia stretching between the two sterno-mastoid and the two sterno-thyroid muscles; behind the œsophagus, on either side, the common carotid artery and internal jugular vein, the recurrent laryngeal nerve, a lobe of the thyroid gland, and the sterno-hyoid and sterno-thyroid muscles.

In the *thorax* the trachea has, in front, the arch of the aorta and the innominate artery; behind, the œsophagus; to the right, the innominate artery; to the left, the left common carotid, the left subclavian and the thoracic duct. The structure of the trachea and bronchi is as follows:—1. A fibrous layer outside with cartilaginous arches imbedded. 2. Behind where the cartilages are deficient is a layer of transverse muscular fibres. 3. Within these, a layer of longitudinal elastic fibres. 4. Most internally, submucous tissue and mucous membrane covered with ciliated epithelia.

The right bronchus is one inch long, and enters the lung opposite the fourth dorsal vertebra. The left bronchus is

two inches long, and enters the lung opposite the fifth dorsal vertebra.

The LUNGS occupy the main part of the thoracic cavity, and project beyond it at the top to the distance of 1½ inches. The lung is free everywhere, except at its root. The named parts of the lung are as follows: apex, base, outer convex surface, inner concave surface, round posterior border and sharp thin anterior border. The apex is conical, the base concave, and rests on the diaphragm. The lung is divided by a fissure which extends from behind the apex downwards and forwards towards the xiphoid cartilage; the part above the fissure is called the *upper*, the part below the lower *lobe*. In the right lung a second fissure passes forward at right angles to the main fissure and reaching the anterior border, cuts off the third lobe of the lung: on the left side no such lobe is found, its place being taken by the heart and pericardium. Hence the right lung is a little larger than the left—the right weighing 20oz., the left 18oz.

The *root* of either lung is found on its inner surface, midway between the apex and base, and midway between the anterior and posterior borders. It consists of the pleura, enclosing the structures found in the roots of the lungs.

The relations of the root of the *right* lung are:—in front, the phrenic nerve, anterior pulmonary plexus, and the superior vena cava; behind, the posterior pulmonary plexus; above, the vena azygos major; below, the ligamentum latum pulmonis. The relations of the root of the *left* lung are: in front, the phrenic nerve and the anterior pulmonary plexus; behind, the posterior pulmonary plexus and the descending aorta; above, the arch of the aorta; below, the ligamentum latum pulmonis. The structures forming the roots of the lungs are:—a bronchus; a division of the pulmonary artery; two pulmonary veins; a bronchial artery; a bronchial vein; branches of nerves from the anterior and posterior pulmonary plexuses; lymphatics and some areolar tissue. The main structures vary a little in relation one to the other. On both sides from *behind forwards* the structures are: bronchus, artery, veins. Owing, however, to the left bronchus having to come low down to get beneath the aorta, the two sides differ as their structures are looked at from the front; they would then be from *above downwards* on the right, bronchus, artery, veins; but on the left,

artery, bronchus, veins. When one traces the bronchus into the lung, it will be found to divide and subdivide and to form by-and-by very small tubes. The bronchi first form smaller bronchi, or bronchioles, but by subdivisions the size is so reduced that capillary bronchi result. As these reach the lung-surface they suddenly dilate to form *infundibula*, on the wall of which the air vesicles exist. These are formed by septa projecting from the wall of the recess, and causing spaces or alveoli, to allow of the air being retained for a time in contact with the blood vessels contained in the walls. To know the structure of the lung, trace the various tissues of the trachea and bronchi into the lung, as follows:—

A small bronchus presents:—1, fibrous tissue, with cartilaginous flakes imbedded in it; 2, a complete layer of circular muscular fibres; 3, a complete layer of longitudinal elastic fibres; 4, submucous tissue; 5, mucous membrane, with ciliated epithelium. Now follow these on to the lung substance:—The fibrous tissue is continued into the lung substance; the cartilaginous tissue ends when the diameter of the tube reaches the 1-25th of an inch; the muscular fibres, submucous membrane, and ciliated epithelia end at the infundibula; and the elastic tissue is continued into the lung substance.

The bronchial arteries and veins and pulmonary plexuses of nerves have been already noticed.

THE ABDOMEN.

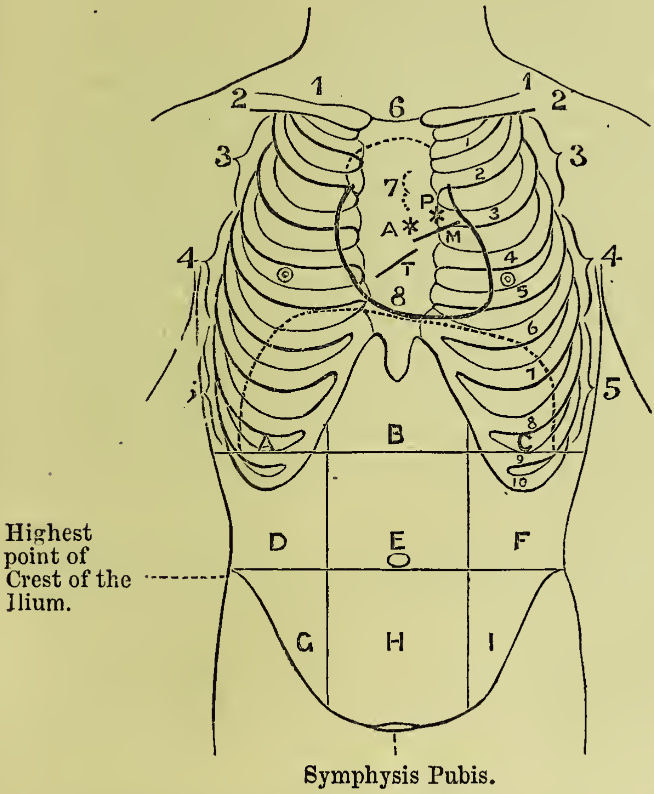
The cavity of the abdomen is bounded above by the diaphragm; below, by the levator ani; in front and at the sides, by the abdominal muscles; and behind by the vertebral column. It is shaped like an egg with the wide end upwards and the point below received within the brim of the pelvis. The relations of the viscera to the wall will be given after the contents are studied.

The wall of the abdomen is formed by muscles and aponeuroses. The *muscles*—1. The external oblique, arises from the eight lower ribs, and goes to be inserted in the crest of the ilium and the aponeurosis. 2. The internal oblique extends from Poupart's ligament and the crest of the ilium, and goes forwards and upwards to the aponeurosis and the lowest three ribs. 3. The transversalis extends from the cartilage of the lower six ribs, from the posterior aponeurosis, and from the iliac crest,

FIG. 14.

DIAGRAM OF THORACIC AND ABDOMINAL REGIONS.

(For full details see pages 91-94.)



The THORACIC regions:—

A, Aortic valve internal to the junction of the third left costal cartilage, with the sternum; P, Pulmonary valve at the junction; M, Mitral valve; T, Tricuspid valve. The *figures* indicate the regions:—1, Supra-clavicular; 2, Clavicular; 3, Infra-clavicular; 4, Mammary; 5, Infra-mammary; 6, Supra-sternal; 7, Upper sternal; 8, Lower sternal. The black line indicates the position of the heart, with its apex, below and internal, to the nipple, and between the 5th and 6th ribs. The dotted line above marks the course of the aorta. The dotted line across the body indicates the position of the diaphragm.

The ABDOMINAL regions:—

A. Right hypochondriac.
B. Epigastric.
C. Left hypochondriac.
D. Right lumbar.
E. Umbilical.
F. Left lumbar.
G. Right inguinal.
H. Hypogastric.
I. Left inguinal.

(For details of contents see pages 91-94.)

and goes forwards to its aponeurosis. 4. The rectus abdominis passes up from the top of the pubes, and goes to the xiphoid cartilage, and the cartilages of the seventh, sixth, and fifth ribs. In its substance are placed the lineæ transversæ. 5. The pyramidalis muscle is a small triangular muscle immediately above the pubes.

The *aponeuroses* of the abdominal wall are best considered in regard to their relations to the rectus. The internal oblique aponeurosis splits on the border of the rectus, part going in front, part going behind. The part going in front carries the external oblique aponeurosis with it; the part going behind carries the transversalis with it; hence the sheath of the rectus is formed by one and a half layers in front and one and a half layers behind. At the lower part all the aponeuroses come in front, and the junction of the internal oblique and transversalis forms the conjoined tendon. The central union is called the linea alba; and at the outer edge of the rectus the linea semilunaris is seen. The fold of Douglas is the spot where the aponeurotic sheath of the rectus ends behind.

The aponeurosis *behind* belongs to the transversalis. It consists of three lamellæ; the posterior goes to the tip of the spinous processes, the middle to the tip of the transverse processes, and the anterior to the root of the same. The posterior lamella is called the lumbar aponeurosis. Between the two posterior lamellæ lies the erector spinæ, and between the two anterior the quadratus lumborum.

The wall of the abdomen is supplied by the lower six intercostal *nerves*, and by the ilio-hypogastric and ilio-inguinal nerves.

The *arteries* in the wall are those derived from the superior epigastric and the deep epigastric; the former comes down from the internal mammary, and the latter passes up from the deep epigastric. At the sides, branches of the intercostal arteries come forward.

Just above Poupart's ligament is the region of *inguinal hernia*. Here exists a weak spot in the abdominal wall, caused by the descent of the testicle; and through it a piece of the intestine or other abdominal viscus may protrude. The testicle lies originally in the abdomen below the kidney, but at the seventh month of fœtal life it travels down, and by the end of the eighth month reaches the bottom of the scrotum. On its way down it

carries with it a process of peritoneum, called the *processus vaginalis,* which getting separated from the general cavity, becomes at its lower part the *tunica vaginalis.* Should the processus vaginalis remain unclosed, a *congenital hydrocele* or a *congenital hernia* may take place; or, again, should it become closed only at the top, a hernia might push its way down behind the open tube, constituting an *infantile hernia.*

The testicle on its way down carries with it—first peritoneum, then sub-peritoneal fat, then it meets with a fascia beneath the transversalis muscle, called the transversalis fascia. The transversalis muscle allows it to escape beneath its lower border, but the internal oblique sends down some loops over the testicle, under the name of the cremaster muscle. The testicle now emerges from the external abdominal ring, over which is stretched the inter-columnar fascia; this it carries in front of it and then descends to the scrotum. The coverings of an *inguinal hernia* are the same: 1. Peritoneum forming the sac. 2. Sub-peritoneal fat. 3. The infundibuliform fascia, from the transversalis fascia. 4. Cremaster muscle, from the internal oblique. 5. Inter-columnar fascia, from the external oblique. 6. Superficial fascia. 7. Skin.

The *external* abdominal ring is immediately above the pubic crest; it is triangular in shape, situated in the external oblique, and wholly aponeurotic.

The *internal* abdominal ring is found half an inch above the middle of Poupart's ligament. It is circular, situated in the transversalis fascia, and is bounded, above and externally, by the transversalis muscle; below by Poupart's ligament; and internally by the deep epigastric artery. When a hernia comes down external to the deep epigastric artery, it is called oblique; when internal, direct; the difference in coverings being, that the direct splits the conjoined tendon.

On opening the cavity of the abdomen the greater sac of the peritoneum is laid open and the position of the viscera seen. The structures seen are:—1. A portion of the liver. 2. The fundus of gall-bladder. 3. The anterior surface of the stomach. 4. The great omentum. 5. The ascending colon in part. 6. The small intestines appearing at the edges of the omentum here and there.

The peritoneum is described as having two sacs, a greater and lesser, communicating through the foramen of Winslow. The peritoneum has various named parts.

1. Omenta, the name given to the reflections connected with the stomach; they are gastro-hepatic, gastro-splenic, and gastro-colic. 2. Mesenteries surround the small intestines; the meso-colon, ascending, transverse, and descending, surround the great; the meso-sigmoid and meso-rectum. 3. Ligaments, the name given to the peritoneal reflections connected with the liver, bladder, and uterus. 4. Fold, the costo-colic fold or fold of Jenner, separates the spleen from the left kidney, and ties up the splenic flexure of the colon.

To trace the peritoneum the ordinary way is to commence at the umbilicus and pass upwards along the abdominal wall to the diaphragm, at the posterior part of which the peritoneum passes on to the liver, forming the upper layer of the coronary ligament of the liver. The liver is covered on its upper and anterior part, and the peritoneum now descends to the stomach, forming the anterior layer of the lesser omentum. Passing over the stomach, it descends to form the anterior layer of the great omentum, and turning back on itself, reaches the colon and forms the under layer of the transverse meso-colon. Here it touches the vertebral column, but is again carried down upon the intestine to form the mesentery. Afterwards it descends to the pelvis, encloses the upper four inches of the rectum, covers the posterior part of the bladder, and ascends to the umbilicus. The same sac of the peritoneum can also be traced transversely, when it will be found to pass from the umbilicus outwards to the side of the lumbar region, embrace the ascending colon on the right, cross the middle line, embrace the descending colon on the left, and pass back to the umbilicus again. The colon is not completely enclosed on either the right or left side. The peritoneum comes close to, but scarcely touches, the kidneys. The *lesser* sac of the peritoneum is to be got at through the *foramen of Winslow*. This aperture is found just below the neck of the gall-bladder. The boundaries are: above, the lobulus Spigelii; below, the first portion of the duodenum; in front, the lesser omentum; behind, the inferior vena cava. The peritoneum in the lesser sac can be traced from the under surface of the liver downwards, forming the posterior layer of the lesser omentum, then down the back of the stomach to get beeween the layers of the greater sac in the great omentum. From hence it ascends over the colon, forming the upper layer of transverse meso-colon,

and, passing up over the pancreas, gets again to the under surface of the liver, where it forms the under layer of the coronary ligament.

THE STOMACH.

The STOMACH presents for examination an anterior and posterior surface; an upper and lower border, two extremities, and two openings. The anterior surface is covered by peritoneum of the greater sac; the posterior by peritoneum of the lesser sac. The upper border has the lesser, and the lower border the greater omentum attached. The pyloric end and opening are together; but the œsophagus enters three inches from the cardiac end.

The *relations* of the stomach are:—in front, the liver, the wall of the abdomen, and the diaphragm; behind, the pancreas, and lesser peritoneal sac; to the left, the spleen; to the right, the liver and gall bladder. Attached to the upper and lower curvatures are the lesser and greater omenta. The wall of the stomach is composed of: 1. peritoneum. 2. Muscular layer, consisting of three sets of muscles, an external, *longitudinal*, running along the upper and lower curvatures; these fibres are continuous with the longitudinal œsophageal fibres on the one hand, and with those of the duodenum on the other. Within the longitudinal are the *circular* fibres; they go completely round the stomach, and are continuous with the circular fibres of the duodenum. The most internal set are the *oblique;* these are continuous with the circular fibres of the œsophagus, but are found only at the cardiac end. 3. The submucous layer, where the blood-vessels and nerves are distributed. 4. The mucous membrane covered by columnar epithelium. The stomach measures from one end to the other from eight to twelve inches.

In the submucous tissue are both mucous and peptic glands. The surface of the mucous membrane presents *rugæ*, or folds when the stomach is empty, which however disappear when food is taken. The surface of the stomach is honeycombed in appearance when looked at with a small magnifying glass; at the bottom of the recesses the glands open.

The œsophageal opening is close to the diaphragm, and about three inches from the cardiac end of the stomach. It is only open when food passes. The pyloric opening is formed by the mucous, submucous, and circular muscular fibres of the stomach. It is usually open, but seems to

have the power of acting as a valve to prevent undigested food passing through.

The *arteries* supplying the stomach, are the gastric, hepatic, and splenic. The lesser curvature is supplied by the gastric, and the pyloric branch of the hepatic; the greater curvature, by the gastro-epiploica dextra from the gastro-duodenal, coming from the hepatic, and by the gastro-epiploica sinistra and vasa brevia coming from the splenic. The nerves supplying the stomach are, besides special ganglia in its substance, the pneumogastric and sympathetic.

THE SMALL INTESTINE.

The *duodenum* consists of three portions, the first or ascending, the second or descending, and the third or transverse.

1. The first stage is two inches long, and extends from the pylorus to the neck of the gall-bladder. It has in relation with it: above, the lesser omentum; below, the pancreas; in front, the liver and abdominal wall; behind the portal vena, gastro-duodenal artery, and the ductus communis choledochus.

2. The second stage is three inches long, and extends from the neck of the gall-bladder to the right side of the third lumbar vertebra. It has in relation with it—in front, the ascending colon; behind, the right renal artery and vein, and ductus communis choledochus; to the right, the abdominal wall; to the left, the pancreas.

3. The third stage is five inches long, and extends from the right side of third lumbar vertebra, to left side of second. It has in relation with it—above, the pancreas; below, the small intestines; in front, the superior mesenteric artery; behind the structures in the middle line.

The *jejunum* is regarded as forming $\frac{2}{5}$ths of the length of the small intestine and the *ileum* the remainder. The structure of the small intestine is much the same as the stomach. 1. Peritoneum; this forms a complete layer to the jejunum and ileum, but in the duodenum it is modified, the first stage being enclosed, the second covered in front, and the third stage only touched by the peritoneum. 2. The muscular layer, longitudinal outside and circular fibres within. 3. The submucous. 4. The mucous layer covered over with columnar epithelium. On the mucous

membrane the following peculiarities are to be observed, partly by naked eye and partly microscopic. Extending the whole length are found:—1. Villi; 2. Lieberkühn's follicles; and, 3. Solitary glands. Occupying only parts of the intestine are—1. Brunner's glands in the first inch. 2. Peyer's patches in the lower two or three feet. 3. Valvulæ conniventes in the upper half.

The *villi* are minute finger-like projections consisting of a layer of epithelial cells; a basement membrane, muscularis mucosæ, and within these blood-vessels and lymphatics. *Lieberkühn's* follicles are depressions lined by epithelium cells and secreting mucus. *Solitary* glands are lymphatics, and correspond to the follicle or medullary portion of a lymphatic gland. *Brunner's* glands are racemose glands, and secrete an alkaline fluid.

Peyer's patches are situated on the free border of the gut; they are from 12 to 18 in number; they decrease in number in advancing years. The length of the longest is 2½ inches.

The *valvulœ conniventes* are circular reduplications of the mucous and submucous layers. They commence 1 inch beyond the pylorus, are best developed opposite the opening of the ductus communis choledochus in the second portion of the duodenum, and end by becoming gradually smaller, about halfway down the small intestine.

The *arteries* supplying the small intestine are the vasa intestini tenuis from the superior mesenteric. These vessels, about twelve in number, form three arches before they reach the intestine, thus equalizing the blood supply to all parts of the intestine. The vessels are distributed in an arborescent manner on the wall of the intestine. The nerves found in the wall of the gut are arranged in plexuses, one between the layers of the muscular fibres, called Auerbach plexus, the other in the submucous coat, called Meissner's plexus.

The *large intestine* consists of the cæcum, colon, sigmoid flexure, and rectum.

The cœcum lies in the right iliac fossa, and ends opposite the highest point of the crest of the ilium. It is 4 inches in depth, is covered in front and at the sides by peritoneum, and lies on the iliac fascia. The small intestine and vermiform appendix open into it. The opening from the intestine is guarded by the *ileo-cœcal* valve. This valve consists of two cusps, an upper and lower; the upper, or ileo-colic, is horizontal; the lower, or

ileo-cæcal, is perpendicular. The free edges of the valves project towards the cæcum; behind, the valves are continued back to form the frænum. The *vermiform appendix* is a muscular tube about 4 inches long, which opens into the cæcum underneath the valve. It is found behind and to the inside of the cæcum. It is present as an undeveloped portion of the colon. The *ascending colon* extends from the highest point of the crest of the ilium to the under surface of the liver, where it forms the hepatic flexure. It is only partially enclosed in peritoneum, being uncovered behind. The relations are: in front, the wall of the abdomen and the great omentum; behind, the right kidney and the quadratus lumborum; to the right, the wall of the abdomen; to the left, the small intestines.

The *transverse colon* extends from the liver on the right side to the spleen on the left, where it forms the splenic flexure, and is tied up by the costo-colic fold of peritoneum to the wall of the abdomen. Owing to its bulging forward in the centre it forms an arch. It is enclosed between the layers of the transverse meso-colon, the upper layer of which is formed by the peritoneum of the lesser, and the lower by the peritoneum of the greater sac. Its relations are: in front, the great omentum; behind, the small intestines; above, the stomach; below, the great omentum.

The *descending colon* extends from the splenic flexure down to the highest point of the crest of the ilium. It is enclosed by peritoneum everywhere except behind. Its relations are: in front, small intestines; behind, the left kidney and quadratus lumborum muscle; to the left, the wall of the abdomen; and to the right, the small intestines.

The *sigmoid flexure* extends from the highest point of the crest of the ilium, and ends opposite the left sacro-iliac synchondrosis. It is the narrowest part of all the great intestine. It is surrounded completely by peritoneum. The relations are: above, small intestines; behind, the iliacus and psoas muscles covered by their fasciæ; the left ureter and the bifurcation of the left common iliac artery lie behind it.

The Rectum will be described with the Pelvic Viscera.

THE LIVER

presents for examination borders, extremities, surfaces, fissures and lobes.

The *borders* are, anterior and posterior. The anterior is thin and sharp, and presents the fundus of the gall bladder; the posterior passes across the middle line, and has a large notch for the vertebral column, to this border is attached the coronary ligament, between the two layers of which is found the inferior vena cava. The *extremities* are right and left. The right is round and thick, and is attached by the right lateral ligament; the left is sharp and pointed, and is slung to the diaphragm immediately in front of the œsophageal opening by the left lateral ligament. The *surfaces* are upper and lower. The upper surface is convex, and has attached to it the falciform ligament; the under surface requires a detailed description. On this surface the division of the liver by fissures into lobes is to be made out. The *fissures* are: 1, the fissure for the umbilical vein; 2, the fissure for the ductus venosus—these two constitute the longitudinal fissure; 3, the transverse or portal fissure; 4, the fissure for the gall bladder; 5, the fissure for the inferior vena cava. These divide the liver on its under surface into *lobes;* 1, the right lobe; 2, the left lobe, smaller than the right, and separated from it by the longitudinal fissure; 3, the lobulus quadratus; 4, the lobulus Spigelii; 5, the lobulus caudatus. The three last are on the under surface of the right lobe, the quadrate being the most anterior, in front of the transverse fissure; the Spigelian and caudate lobules are behind the transverse fissure. At the portal or transverse fissure the structures passing in and out of the liver are found. They are contained in the lesser omentum, and consist of the following:—Portal vein, hepatic artery, hepatic ducts, lymphatics, branches of the left pneumogastric and sympathetic nerves, and loose areolar tissue.

The *peritoneum* forms the ligaments by which the liver is fixed, and completely encloses it except between the layers of the coronary ligament, and where the gall bladder and inferior vena cava touch. Beneath the peritoneum is the capsule, which at the gate of the liver is prolonged into the interior with the vessels as Glisson's capsule.

The *relations* of the liver are:—*Above,* the diaphragm

and the falciform ligament; *below*, the pyloric end of the stomach, the gall bladder, the hepatic flexure of colon, duodenum, supra-renal capsule and right kidney; *in front*, the wall of abdomen; *behind*, the coronary ligament, the diaphragm and its crura, the aorta, inferior vena cava, thoracic duct, vena azygos major, and splanchnic nerves.

The liver is composed of cells, polygonal in shape, about one eight-hundredth of an inch in size. The cells are held together in groups by the connecting tissue, or parenchyma of the liver, to form lobules. The tissue is so arranged in the lobule that the cells lie in rows radiating from the centre. In the connective tissue between the lobules, branches of the portal vein form the *interlobular* veins; these vessels pass into the outer zone of the lobule where the blood is collected into a fine plexus towards the centre of the lobule, called the *intra-lobular* plexus. The blood now emerges as a single trunk from the centre of the lobule, called the *sublobular* vein, and joins others to form the *hepatic* vein.

During the passage of the blood through the liver, bile is extracted from out of the blood in the portal vein, and handed over to a special set of vessels, the *biliary capillaries.* These vessels run between the various liver cells, and collect at the gate of the liver to form the *right and left hepatic* ducts. The two soon unite to form the *common hepatic duct,* which after being joined by that of the gall bladder—the *cystic duct,* is named the *ductus communis choledochus.* This duct passes down the back of the duodenum, where it is joined by the *pancreatic* duct, and then enters the middle of the second portion of the duodenum posteriorly. The place where the most active preparation of the bile takes place is in the intermediate zone of the lobule, at the junction of the interlobular and intralobular plexuses of veins. Here it is that the hepatic artery is distributed, carrying oxygen to the region where the chemical change necessary to the formation of bile is going on. Besides secreting bile, the liver also secretes glycogen, which finds its way into the intralobular veins, and so to the sublobular and hepatic veins. It has therefore no special set of ducts, but leaves the liver by the hepatic vein. Should the common hepatic duct be blocked up by the presence of a gall stone, &c., the bile would also escape by the hepatic vein and set up jaundice.

THE PANCREAS

is a large acinous gland situated close to the vertebral column, reaching from the right to the left side of the vertebræ.

The named parts are :—The head, body, and tail, and the lesser head or pancreas. The head is on the right side of the vertebral column, in contact wth the duodenum. The body crosses the middle line opposite the second lumbar vertebra, and presents an upper and lower border and an anterior and posterior surface. The tail touches the spleen. The lesser head is a process beneath the head of the pancreas, and partly separate from it by the superior mesenteric vessels.

The relations of the pancreas are :—*Above*, the cœliac axis in the middle, to the right the duodenum, to the left the splenic artery; *below*, the superior mesenteric vessels in the centre, the duodenum to the right, and the inferior mesenteric vein to the left. *In front*, the ascending layer of the lesser sac of peritoneum and the stomach; *behind*, the structures in the middle line. The *head* is in contact with the duodenum, and the tail touches the spleen. The *arteries* supplying the pancreas are, pancreatica magna and pancreaticæ parvæ from the splenic; the superior pancreatico-duodenal from the gastro-duodenalis, and the inferior pancreatico-duodenalis from the superior mesenteric. The duct of the pancreas, sometimes called the canal of Wirsung, joins the ductus communis choledochus.

THE SPLEEN

lies in contact with the cardiac end of the stomach, and fixed to it by the gastro-splenic fold of peritoneum. It measures usually $4\frac{1}{2}$ inches from above downwards, $3\frac{1}{2}$ inches in breadth and $1\frac{1}{2}$ inches in thickness. The average weight is 6 oz.

The named parts are :—An upper and lower end, an inner and outer surface, and an anterior and posterior border. The inner surface presents the hilus at which the vessels pass in and out. The spleen is sometimes notched at its anterior and outer part by the ribs.

The relations of the spleen are :—*Above*, the diaphragm ; *below*, the costo-colic or pleuro-colic fold, or fold of Jenner,

separating the spleen from the left kidney; *externally*—*i.e.*, to the left—the diaphragm; *internally*, the splenic vessels, the tail of the pancreas, the lesser sac of peritoneum and the stomach. The *posterior* border rests on the diaphragm; the *anterior* border lies close to the margins of the left costal cartilages.

The *artery* supplying the spleen is the splenic, a branch of the cœliac axis. This artery pursues a tortuous course along the upper border of the pancreas on its way to the spleen. As it approaches the spleen it divides into four or five branches, which find their way into the hilus, and finally into the tissue of the spleen (*see* Portal Vein).

THE KIDNEYS

are situated on a plane posterior to all the other viscera, and as they do not move, the peritoneum does not enclose them. The peritoneum comes close to the anterior surfaces, and in some instances touches. They measure 4 inches from above downwards, 2 inches from side to side, and 1 inch in thickness. The right kidney weighs $4\frac{1}{2}$ oz.; the left $4\frac{3}{4}$ oz. The named parts are: upper and lower ends; inner and outer borders; anterior and posterior surfaces. On the inner border is the hilus, giving entrance and exit to the various structures passing in and out of the kidney.

The relations of the kidneys vary a little on the two sides. The left kidney extends higher than the right; the right reaches the lower border of eleventh rib, the left the upper border. The other differences are easily understood. *Relations* of the *right* kidney: Above, the supra-renal capsule and liver; below the crest of the ilium; in front, the ascending colon; behind, the quadratus lumborum muscle, the last rib, the diaphragm, the psoas muscle, and branches of the lumbar plexus of nerves; to the outside, the wall of the abdomen; and to the inside the vessels entering it. The relations of the *left* kidney are the same, with the exception that the spleen is above, and the descending colon is in front of it. The *arteries* supplying the kidneys are the right and the left renal; they arise from the aorta and pass straight out towards the hilus. Before entering, the main trunk divides into four or five branches, which enter the hilus most anteriorly of all the structures that pass out and in.

On tracing the vessels into the kidney, it will be found that they divide about halfway along the kidney substance, that is, about the base of the pyramids, and from this point of division one set of branches pass outwards and another inwards. Those passing inwards run down between the various tubules of the pyramids, constituting the arteriolæ rectæ; those passing outwards give off branches which form the glomeruli or tufts contained within the Malpighian capsules. To make a section of the kidney, to see its condition or structure, one holds the kidney in the left hand with the inner border downwards, and cuts from the outer border down to near the inner border. It will then be seen that three things have to be noticed, the capsule, the cortex, and the medullary portion. The *capsule* of the kidney is continuous with the connective tissue or parenchyma of the kidney, and again at the hilus become continuous with the ureter. In health it should peel off with a certain amount of fixity to the kidney, but without tearing the substance. The *cortical* and *medullary* portions of the kidney are formed mainly of tubules, and according as these are arranged in a convoluted or parallel manner so we have the cortical and medullary parts of the kidney respectively. The naked eye examination of the kidney will accordingly only show the outer, or cortical portion as a heterogeneous mass, whereas the tubes of the inner or medullary portion are grouped together to form the pyramids of the kidney. About twelve in number, these pyramids have their base outwards, and their apices inwards, and are received in a calyx or cup of fibrous tissue derived from the ureter. On squeezing the apex of a pyramid urine can be caused to ooze, and it will be found that there are about a score of openings in each pyramid. To follow most readily the tubuli of the kidney, commence at the Malpighian capsule. Here it will be found microscopically, that a small branch of the renal artery, the *afferent* vessel, enters the capsule and forms a fine plexus or *glomerulus*, whilst the blood is circulating in this fine plexus, the urine filters through the capillary walls and escapes into the urine tubule. The vein, or *efferent* vessel, emerges at the spot where the afferent vessel enters, and forming a fine plexus outside the capsule and upon the commencement of the urine tube, finally collects to form the radicles of the renal vein. The urinary tubule forms its *first convoluted portions* immediately it emerges from the Malpighian

capsule; it then descends, forming the *descending limb of the looped tube of Henle,* reaching some distance into the base of the pyramid. The bend or *loop* is now formed, and the tube passes from out the pyramid towards the cortex forming the *ascending limb of the looped tube.* Here the *second convoluted portion* is formed, and the tube passes back again to the pyramid under the name of the *collecting* or *receiving* tube. In this part the tubules unite to form a large trunk, called the *excretory* tube. Finally, the excretory tubes discharge the urine by about a score of openings at the apices of the pyramids.

THE URETER

is a fibro-muscular tube, about 18 inches long, which passes from the hilus of either kidney to the bladder. At its upper end it dilates to form the *pelvis,* and is received within a recess in the kidney substance, called the *sinus.* The pelvis in part becomes continuous with the kidney capsule, and in part breaks up to form funnel-shaped prolongations or *infundibuli.* These, three or four in number, are each again subdivided to form cups or *calyces,* to receive the apices of the pyramids. The ureter in its course downwards lies behind the peritoneum, and on the psoas muscle; it then crosses over the common iliac vessels, being behind the sigmoid flexure on the left side and the end of the ileum on the right. Finally the ureter gets into the recto-vesical fold of peritoneum and enters the bladder obliquely at the back part of the trigonum vesicæ.

THE BLADDER

is situated within the true pelvis, and projects beyond it only when distended.

The named parts of the bladder are: The *apex,* slung up by the urachus. The *body,* partly surrounded by peritoneum. The *fundus,* showing internally the trigonum vesicæ on the floor of the bladder. At this spot the tissues are all firmly welded together, so that it does not collapse when the bladder is empty. The trigone is bounded behind by the opening of the two ureters, and in front by the opening of the urethra; it is an equilateral triangle measuring $1\frac{1}{2}$ in. on every side. The *neck,* which in the male is embraced by the pro-

state. The peritoneum, in connection with the bladder, forms the *false ligaments*. These are five in number, a superior, two lateral, and two posterior or recto-vesical. The peritoneum is limited above by the urachus and the two obliterated hypogastric arteries. On the sides the same arteries limit the peritoneal reflexions, and behind the peritoneum descends as low as the opening of the two ureters.

The *true ligaments* are also five—viz., the superior, formed by the urachus; two anterior or pubo-prostatic ligaments, and two lateral, formed by pelvic fascia.

Below the level of the peritoneal reflexions, the vesical portion of the recto-vesical fascia covers the bladder.

Beneath the peritoneal and fascial coverings are the *muscular fibres*. The external set consist of anterior and posterior bands which run from the urachus to the prostate. They go by the name of the *detrusor urinæ* muscle. The internal set form figure of "8" loops, chiefly around the lower part of the bladder, constituting the *sphincter vesicæ*. A third set of fibres is found surrounding the mouths of the ureters. Within the muscular layer are found the submucous or fibrous coat, and the mucous membrane internally covered by *transitional* epithelium.

The relations of the bladder, when moderately distended, are: *above*, the small intestines and great omentum; *below*, the rectum, prostate, vasa deferentia, and vesiculæ seminales; *behind*, the small intestines; *in front*, the back part of the triangular ligament and the pubes. On the sides of the bladder are found the peritoneal reflexions, the obliterated hypogastric arteries, the vasa deferentia, and the blood-vessels supplying it. The *arteries* supplying the bladder are: the superior and middle vesical arteries coming from internal iliac along the obliterated hypogastrics; the inferior vesical coming directly from the internal iliac. The arteries are in pairs. The *veins* open into the internal iliac. The *spinal* nerve to the bladder is derived in common with that to the rectum from the fourth sacral.

THE PROSTATE

embraces the neck of the bladder and nerves as a fixed point in the mechanism for the passage of semen. It is horse-chestnut in shape, with its apex forwards at the

posterior layer of the triangular ligament, and its base around the neck of the bladder. The greatest breadth of the prostate is one inch and a half, its length is one inch and a quarter, and its thickness is one inch. It consists of fibrous tissue, interspersed with muscular fibres, elastic tissue, blood-vessels, sympathetic nerves, lymphatics and secreting glands. All these are arranged in three lobes, two lateral, and a central or third; and the whole held together by a capsule. The outer capsule is derived from the vesical portion of the recto-vesical fascia, and within it is the prostate plexus of veins, joined in front by the dorsal vein of the penis. Within the venous plexus is the true capsule of the prostate.

The relations of the prostate are: in front, the triangular ligament; above and in front, the symphysis pubis; above, the pubo-prostatic ligament; above and behind, the bladder; behind, the bladder; below and behind, the vas deferens and vesiculæ seminales; below, the rectum; below and in front, the perineum. The arteries supplying the prostate are the inferior vesical, and the middle hæmorrhoidal. The veins join the internal iliac.

THE RECTUM

extends from the end of the sigmoid flexure at the left sacro-iliac synchondrosis to the anus. It is divided into three stages.

I. The first, or oblique stage, extends from the left sacro-iliac synchondrosis down to the middle of the third piece of the sacrum. It measures three and a half inches in length, and has: in front, small intestines; behind, the left internal iliac vessels, the left sacral plexus, the left pyriform muscle and the left ureter; to the right, the right internal iliac vessels; and to the left, the left obliterated hypogastric artery. The peritoneum forms a nearly complete enclosure, a *meso-rectum.*

II. The second, or horizontal stage of the rectum, reaches from the middle of the sacrum to the tip of the coccyx. It measures three inches in length, and has—above, the small intestines, the fundus of the bladder, the vesiculæ seminales, the vas deferens and the prostate; below, the sacrum and coccyx, the pyriformis and coccygeus muscles; on either side the levator ani muscles. The peritoneum is in contact only with the upper part of the second stage.

III. The third, or perpendicular stage, passes from the tip of the coccyx to the anus. Its length is one and a half inches, and it has—in front, the perineum; behind, the tip of the coccyx; on either side the insertion of the levator ani muscles. At the junction of the second and third stage the prostate touches the rectum. The third stage of the rectum is destitute of peritoneum.

The rectum consists of the following coats: externally, the peritoneum embraces the upper four inches; the lower four inches are covered by the rectal portion of recti-vesical fascia. Next, the muscular coat, consisting of longitudinal fibres outside, circular fibres within; the circular fibres are collected below to form the internal sphincter muscles. Next the submucous coat. The mucous membrane presents three folds, folds of Houston. The arteries supplying the rectum are: the superior hæmorrhoidal from the inferior mesenteric; the middle hæmorrhoidal from the internal iliac, and the inferior hæmorrhoidal from the internal pudic. The veins communicate with both the portal and systemic circulation.

The Arteries within the cavity of the abdomen.

The Aorta. This vessel is about five inches long; it extends from the diaphragm, coming from between the two crura, down to the fourth lumbar vertebra, on the left side of which it bifurcates. The relations are:—in *front*, the liver, stomach, pancreas, mesentery, duodenum, and the left renal vein; behind, the bodies of the vertebræ, anterior common ligament, commencement of the thoracic duct and of the vena azygos major and minor; to the *right* the inferior vena cava, and the right crus; to the left, the left crus, and the viscera on left side of the abdomen.

The branches are—

1. The inferior phrenics, or diaphragmatic arteries.

2. The cœliac axis, a trunk about three-quarters of an inch in length, arising almost as soon as the artery has come through the diaphragm. It divides into three. (*a.*) The *gastric* runs along the lesser curvature of stomach, and anastomoses with the pyloric branch of the hepatic. (*b.*) The *hepatic* runs up between the layers of the lesser omentum, to get to the liver. On its way it gives off the *pyloric* to the lesser curvature; the *gastro-duodenal*, which, passing down behind the first portion of the duodenum, divides into (*α*) pancreatico-duodenalis superior, and (*β*) the gastro-epiploica dextra.

The former runs between the pancreas and duodenum; the latter runs along the greater curvature of the stomach. The hepatic artery now ascends in the lesser omentum, and divides into right and left. The right gives off the *cystic* to the gall bladder, and the two trunks, continued on into the liver, supply branches to the capsule, vessels, and lobules; these are, *capsular*, *vascular*, and *lobular*. (*c*.) The *splenic* runs along the upper border of the pancreas, and before reaching the spleen divides into four or five terminal trunks. Its branches are: α, pancreaticæ parvæ; β, pancreatica magna; γ, vasa brevia to the cardiac end of the stomach; δ, gastro-epiploica sinistra to join the dextra at the greater curvature of the stomach.

3. The superior mesenteric artery arises from the anterior aspect of the aorta, about half an inch below the cœliac axis. It passes down in the mesentery, having its convexity to the left. From the convexity are given off the (*a*) *vasa intestini tenuis;* from the termination, the (*b*) *ileocolic;* and, from the concavity (*c*), the *colica dextra*, and (*d*) the *colica media*. A small branch is given off at the commencement, the (*e*) *inferior pancreatico-duodenalis*. These branches are distributed as their names imply, and form arches and frequent anastomoses before their final distribution.

4. The inferior mesenteric artery arises two inches above the bifurcation of the aorta, and passes towards the left side. The branches are:—*colica* dextra, to the descending colon; *sigmoid*, to the sigmoid flexure; and *superior hæmorrhoidal*, to the rectum. The superior hæmorrhoidal runs along the back of the rectum to near the anus.

5. The supra-capsular, are two small branches given off just above the renal to the supra-renal capsule. They are often called the *middle* capsular, as *superior* branches are frequently given off from the phrenic, and *inferior* branches from the renals to supply the capsules.

6. The renal arteries are two short trunks which arise from the sides of the aorta at right angles, and pass almost straight out to the kidneys. They are in diameter about half-an-inch. The right is slightly longer than the left, owing to the aorta being on the left side of the middle line. Each passes across the corresponding crus of the diaphragm and the psoas muscle. The right passes behind the inferior vena cava, but both arteries are behind their corresponding veins. The branches are:—(*a*) *inferior*

capsular to the supra-renal capsules. The trunk breaks up into four or five branches before it reaches the kidney.

7. The spermatic arteries arise from the sides of the aorta, about halfway down. They were originally short trunks when the testicle lay below the kidney; but owing to the descent of the testicle, each vessel lengthens out into a long slender branch which passes across the psoas muscle, over the iliac fossa, along the inguinal canal, and hence by the spermatic cord to the testicle. There it is distributed in the tunica vasculosa. Small branches are given off to the ureter and to the vas deferens.

8. The lumbar arteries, of which there are four pairs, pass out from the sides of the aorta, get beneath the fibrous arch of the psoas muscle, and divide into *abdominal* and *dorsal* branches which run as their names imply.

9. The sacra media is the real continuation of the aorta down the front of the sacrum.

II. The COMMON ILIAC ARTERIES are really branches of the aorta. They commence at the bifurcation of the aorta on the left side of the fourth lumbar vertebra, and run downwards and outwards to the sacro-iliac synchondrosis of either side. The right, two inches long, is slightly longer than the left. Relations: — in front, peritoneum, small intestines, ureter, sympathetic nerves; behind, the body of the fifth lumbar vertebra; outside both are the psoas muscles; and inside, the hypogastric plexus of nerves. The relations to veins is given with the iliac veins.

III. The external iliac arteries commence at the sacro-iliac synchondroses, and end below, at Poupart's ligaments, by becoming the common femorals.

Relations:—The vessels are first internal to, and then upon, the psoas muscles. They are covered over by peritoneum, and have crossing them the intestines, the circumflex iliac veins, the vasa deferentia; the left artery is crossed by the rectum. For the veins, *see* below.

The branches are:—1. The *deep epigastric*. This vessel is given off from from the external iliac, close to Poupart's ligament; it passes up internal to the internal abdominal ring, and ascending in the rectus muscle, meets the superior epigastric from the internal mammary, when a free anastomosis takes place. The branches are (a) pubic; (β) cremasteric; (γ) muscular; (δ) anastomosing.

The pubic branch goes to the back of the pubes; the cremasteric to the cremasteric muscle. 2. The *deep circumflex iliac* passes outwards amongst the muscles of the abdominal wall, and anastomoses with the ilio-lumbar and lumbar arteries.

IV. The internal iliac arteries commence opposite their corresponding synchondroses, and running down for an inch into the pelvis on either side of the rectum, divide into two sets of branches—an anterior and posterior.

The *anterior* group consists of:—1. *Superior* vesical. 2. *Middle* vesical. 3. *Inferior* vesical. The vesical arteries run, as their names imply, to the bladder. The two upper run along the obliterated hypogastric artery for some distance before they reach the bladder. 4. The *obturator* runs along the side of the pelvis to the obturator foramen. It passes through the foramen with the nerve and vein. The artery does not perforate the membrane, but passes in a groove above. On emerging from the foramen it divides to embrace the origin of the obturator externus, and there it anastomoses with the internal circumflex. 5. The *middle hæmorrhoidal*. 6. The *uterine* and *vaginal* in the female. 7. The *sciatic* passes through the great sacro-sciatic foramen below the pyriformis, and divides into: (*a*) muscular; (*b*) anastomosing; (*c*) coccygeal; and (*d*) comes nervi ischiadici. 8. The *internal pudic* leaves the pelvis by the great sacro-sciatic foramen below the pyriformis, crosses the back of the spine of the ischium, and again enters the pelvis through the lesser sacro-sciatic foramen. It passes along the side of the ramus of the pubis to the perineum, and gives off: (*a*) inferior hæmorrhoidal; (*b*) the superficial perineal, giving off the transverse perineal; (*c*) the artery to the bulb, giving off the artery to Cowper's gland; (*d*) the artery to the corpus cavernosum; (*e*) the dorsal artery of the penis. The *posterior* group consists of:—1. The *gluteal* artery passes through the great sacro-sciatic foramen above the pyriformis, and divides into: (*a*) superficial; and (*b*) deep; the deep divides into (α) superior; and (β) inferior. 2. The *ilio-lumbar*. 3. *Lateral sacral.*

The VEINS in the cavity of the abdomen consist of two sets—the systemic and the portal.

A. The *systemic* set consists of the inferior vena cava and the veins connected with it. The blood ascends from

the lower extremities by the femoral veins. These pass beneath Poupart's ligament, and at that spot lie internal to their corresponding arteries. The *external iliac* veins differ on the right and left sides, owing to the inferior vena cava being on the right side of the body. The *left* vein commences at and keeps to the inside—*i.e.*, the right side—of the external iliac artery the whole way along. The *right* vein commences internal to—*i.e.*, on the left side of, its artery—and then passes beneath the artery to get on its outer side. The *internal iliac* veins ascend to join the external, to form the *common iliac* veins. The *left* common iliac vein is much the longer; it has to cross the middle line to reach the cava. On the way across it keeps below the level of the bifurcation of the aorta, and beneath the trunk of the right common iliac artery, where it joins the right common iliac vein to form the vena cava. The branches joining the iliac veins correspond to the branches of the arteries.

The *inferior vena cava* commences on the right side of the fifth lumbar vertebra and ascends to the diaphragm to reach the right auricle. The vein, at its commencement, is placed deeply against the bodies of the vertebra, but as it ascends it gradually leaves the bones, and finally passes through the diaphragm some distance in front of the vertebral column. The opening in the diaphragm is on the right side, it is aponeurotic in character and quadrilateral in shape. The *veins joining* the inferior vena cava after its formation by the common iliacs are: 1. The two lower pairs of lumbar veins; the two upper pairs of lumbar veins join the vena azygos major on the right side, and the minor on the left. 2. Communicating branches with the azygos veins. 3. The right spermatic. 4. The right and left renals. The *right* renal vein is shorter than the left, owing to the cava being on the right side; it is joined by the capsular vein from the supra-renal capsule. The *left* renal vein is the longer, it passes in front of the aorta, below the superior mesenteric artery, and under cover of the third portion of the duodenum. It is joined by the (*a.*) left capsular, (*b.*) the left spermatic, and (*c.*) the left inferior phrenic. 5. The hepatic vein joins at the spot where the inferior vena cava touches the liver, and passes immediately into it; the vein has four or five separate openings. 6. The right inferior phrenic is the last vessel that joins the inferior vena cava.

G 2

The veins in the cavity of the abdomen, both portal and systemic, lie on the right of the arteries; the inferior vena cava is on the right side, it commences lower down than, and on a plane posterior to, the arteries, but as it ascends it comes to be in a plane in front of them. The *relations* are: in *front*; the liver, the duodenum, the pancreas, and the small intestines; the right spermatic, and the right common iliac arteries cross it; *behind*, the right psoas and the diaphragm; the right inferior phrenic, the right capsular, the right renal, and the right lumbar arteries lie between it and the posterior abdominal wall.

The Portal Vein is formed behind the head of the pancreas by the junction of the superior mesenteric and splenic veins; these vessels are almost identically similar in their course and branches to their corresponding arteries, the chief exception being that the inferior mesenteric vein joins the splenic; the portal vein thus formed, runs up for a distance of four inches, passing behind the pylorus, and in the lesser omentum to the gate of the liver. The lesser omentum contains also the hepatic artery and the ductus communis choledochus, the relations being the artery to the left, the duct to the right, and the vein behind and between both. The veins joining the portal vein, after its formation, are: the (*a*) gastric, and (*b*) cystic. At the gate of the liver the vein divides into right and left, and, breaking up into fine branches, forms the interlobular veins. In the lobule the blood re-assembles to form the intralobular plexus, and finally emerges as the sub-lobular. These unite together to form the hepatic, which joins the inferior vena cava close to its ending at the diaphragm.

THE OVARY, UTERUS, AND VAGINA.

Contained between the folds of the broad ligament of the uterus on either side are: the ovary, Fallopian tube, and round ligament. Looking at the broad ligament, the Fallopian tube will be seen to be the highest up, the ovary to be below the tube and to project posteriorly, and the round ligament, the lowest.

The *ovary* is about one inch and a half in its longest or transverse axis, and about one inch in breadth. It is composed of: fibrous tissues interspersed with mus-

cular and elastic fibres; the branches of the ovarian artery; lymphatics, and sympathetic nerves. The posterior or peritoneal surface is composed of cells, called germ epithelial cells. These sink down into the ovary and form ovigerms; and these ovigerms may become developed into ova. When an ovigerm begins to acquire round about itself a small quantity of fluid, the ovarian tissue becomes distended and a Graafian vesicle is formed. This consists of a capsule, with a lining of cells, the tunica granulosa, the cells of which, as they are heaped around the ovum, form the *discus proligerus*. When the ovum escapes from the vesicle a corpus luteum is formed. (For further account, *see* Midwifery.)

The ovum may now escape into the Fallopian tube. The FALLOPIAN TUBES are about four inches long, and serve to conduct the ova from the ovary to the uterus. The outer end of the tube is open, and has a number of fimbriæ, which grasp the ovum and pass it into the open tube. In about a week's time the ovum reaches the uterus, and there it may be ejected or develop. The outer end of the tube is wider than the inner end; it is called the ampulla. The tube consists of peritoneum outside, circular and longitudinal muscular fibre within, and then a submucous coat and mucous membrane, covered with ciliated epithelium.

The UTERUS or womb lies between the layers of the broad ligament. The peritoneum, as it passes forwards from the rectum, presents a fold on either side, the recto-vaginal, and between the two the pouch of Douglas. The peritoneum passes first on to the back of the vagina, then over the top of the uterus and down the anterior surface. In front, the vagina is not touched, as the peritoneum passes straight from the uterus to the bladder, forming the utero-vesical folds. The virgin uterus is pear-shaped, with the fundus upwards; it is 3 inches in length, 2 inches wide, and 1 inch in thickness. All its walls are convex, both externally and internally. Its *structure* is: outside, *peritoneum*, with the limits given above; *involuntary muscular fibres*, which are best seen in the pregnant uterus; they consist of three layers: an external longitudinal layer, collected as two bands on the anterior and posterior walls; an internal layer collected in circles round the openings in the uterus; and an intermediate set, without any definite arrangement, except that some are grouped around the blood-vessels.

Within the muscular layer is the *mucous membrane*, with a number of glands in its substance, and covered with ciliated epithelium. There is no submucous coat. The *arteries* supplying the uterus are, the uterine from the internal iliac, and a few branches from the ovarian. The veins correspond to the arteries.

The named parts of the uterus are, body, and neck or cervix. The body forms two-thirds of the whole, and the cervix the lower one-third. They together present an anterior surface. a posterior surface, lateral borders having the broad ligaments attached, a base or fundus, and below the os uteri. On opening the cavity of the uterus it will be found that the walls are all convex, and that there is a constriction between the body and cervix, called the internal os. The cavity of the *body* consequently presents three openings: above and on either side the openings of the two Fallopian tubes, and below the internal os or ostium internum; all these openings are circular. The cavity of the *cervix* presents the circular or internal os above, and the external os below. The external os is a slit rather than a foramen. It has its long axis transversely, and presents an anterior and a posterior lip; it measures five lines in its long diameter. In the virgin its lips are smooth, but in the mother the lips are notched and scarred. On the anterior and posterior walls are seen the arbores vitæ, or longitudinal ridges with lateral offshoots like the branches of a tree, hence the name arbor vitæ. Amongst the ridges a few round white swellings, glands of Naboth are to be seen.

The Vagina extends from the vulva to the os uteri which it embraces. It is touched by the peritoneum at the upper and back part. Its walls consist of fibrous tissue outside; within this is the muscular layer, composed chiefly of longitudinal fibres; still more internally, a layer of erectile tissue, submucous tissue, and mucous membrane. On the anterior and posterior walls are found ridges called the columns of the vagina, best seen in the virgin. The anterior wall of the vagina measures about four inches, and is attached to the anterior lip of the uterus. The posterior wall is about six inches long, and runs up behind the posterior lip to get on to the uterine wall. Consequently the posterior lip projects some little distance into the vaginal wall. The walls of the vagina are in apposition. The arteries supplying it are the vaginal, vesical and hæmorrhoidal. The *vulva* presents for

examination the mons veneris, the clitoris, the labia majora; the labia minora or nymphæ. The vestibule is the space between the clitoris and the urethra; it is nearly an inch long. Within the opening of the urethra is the hymen; when ruptured, the remains form the caruncula myrtiformis. The labia majora meet behind at the posterior commissure, and the labia minora at the fourchette. These are simply slight transverse elevations, the external consisting of skin, the internal of mucous membrane. The interval between the two is called the fossa navicularis. The opening or *rima* of the vulva is embraced by the sphincter vaginæ.

THE RELATIONS OF THE THORACIC AND ABDOMINAL VISCERA TO THE SURFACE OF THE BODY.

The *thorax* is portioned off into regions by various imaginary lines:—

I. The anterior or median or sternal region corresponds to the width of the sternum; this is again divided into three—the *supra-sternal*, the *upper* sternal, and the *lower* sternal. The supra-sternal region is the depression above the sternum. The upper extends as low as the third cartilage, and the lower from hence to the end of the sternum.

II. The antero-lateral region extends from the sternum to a line drawn from the acromion process down the anterior fold of the axilla to the lower border of the ribs. This is subdivided into the *supra-clavicular*, *clavicular*, *infra-clavicular*, *mammary*, and *infra-mammary* region. The first is bounded below by the clavicle, and above by a horizontal line drawn from the outer third of the clavicle to the middle line; the clavicular is underneath the clavicle; the infra-clavicular extends as low as the third rib; the mammary from hence to the sixth; and the infra-mammary from the sixth to the lower border of the ribs.

III. The lateral or axillary region is bounded in front by the acromial line, and behind by a line drawn parallel to the axillary border of the scapula. The subdivisions are:—the *axillary*, which extends from the apex of the axilla to the point where the line prolonged back from

beneath the mammary region passes along the lateral wall of the chest. The *infra*-axillary extends from hence to the lower margin of the ribs.

IV. The postero-lateral, posterior, or scapular region extends from the axillary border of the scapula to the middle line. It is subdivided into the *supra-spinous* region, the *infra-spinous*, the *infra-scapular*, and the *inter-scapular*. These names imply the limits; the infra-spinous region however extends inwards to the spine below. The lungs and heart are the only viscera that occupy the thorax, but, owing to the arching of the diaphragm upwards, the liver, stomach and spleen are accommodated on its under surface, and are found to be beneath the ribs, and lie within the limits of the regions of the thorax that have been mapped out.

The Lungs occupy the greater part of the chest wall, and their position can be elicited by percussion. It will be found that they extend above the clavicle for about an inch; that the anterior border of the right lung runs down as low as the sixth cartilage, but that the left comes no lower down than the fourth. This is accounted for by the heart pushing the left lung towards the left. The spot where percussion elicits the most typical sound is over the "physician's triangle," behind the inferior angle of the scapula. This space is destitute of muscular covering, and is bounded above by the rhomboideus major, below by the latissimus dorsi, and internally by the trapezius. The point of entrance of the bronchi right and left will be found opposite the fourth and fifth vertebræ respectively.

The Heart *and great vessels* have definite relations to the chest wall, and it is all important to know them. The area of the heart's dulness is called the *præcordial* region. It is triangular in shape, with the apex at the spot where the fourth cartilages join the sternum. The base is at the diaphragm, but there the heart and liver dulnesses are continuous, so that it is impossible to limit the area of the heart's dulness below by percussion. The lateral limits are formed by the lungs; owing however to the anterior border of the right lung descending as far as the sixth cartilage, whilst the left lung departs from the sternum opposite the fourth cartilage, the boundaries formed by the lungs are not symmetrical. The extent of the area of the heart's dulness occupies altogether a space about two inches square. The various *points* im-

portant to know are as follows. The *nipple* in males is over the fourth rib, one inch external to the cartilage. The *apex of the heart* is two inches below the nipple, and one inch to the sternal side; it will therefore be found between the fifth and sixth ribs. The *commencement of the aorta* is behind the sternum opposite the junction of the third costal cartilage. The spot where the *aorta comes nearest the surface* is behind the second right costal cartilage. The commencement of the *pulmonary artery* is close to the left side of the sternum, just where the third left costal cartilage joins it. The *right auriculo-ventricular* opening is behind the middle of the sternum, opposite the junction of the fourth costal cartilages. The *left auriculo-ventricular opening* is slightly to the left of the aorta orifice. The *base of the heart* corresponds to the dorsal vertebræ from the fifth to the eighth inclusive. As the valves of the left side of the heart are practically the only set liable to disease it is important to know where to listen for the inclosure. The closure of the mitral valve is heard best at the apex, not because the mitral valve is there, but because the cavity which contains the mitral valve—the left ventricle—comes at that spot nearest the surface of the chest wall. For the same reason the closure of the aortic valve is best heard behind the second right costal cartilage.

The Abdomen is also mapped out into regions by circles and lines. To commence with, take an imaginary *circle* round the body opposite the cartilage of the *ninth rib*, and another opposite the *highest point* of the crest of the ilium. Three zones are accordingly found, the *upper* limited by the diaphragm above, and by the upper circle below; the *middle* limited by the upper and lower circles; and the *lower* by the lower circle above, and by the brim of the true pelvis below. Now draw two perpendicular *lines* from the centre of Poupart's ligament on either side up to the cartilage of the eighth ribs. The abdomen is now divided into three regions, a central and two lateral; and each of these is again subdivided into three, making nine in all.

The regions and their contents are :—

A. On the right side.

I. The right hypochondriac contains :—1. The right lobe, and part of the left lobe of the liver. 2. The pylorus. 3. The first portion of the duodenum. 4. The gall bladder. 5. The hepatic flexure of the colon.

6. The right supra-renal capsule. 7. The top of the right kidney.

II. The right lumbar contains :—1. The main part of the right kidney. 2. The ascending colon. 3. Part of the small intestines.

III. The right iliac contains :—1. The cæcum. 2. Part of the small intestines.

B. On the left side.

I. The left hypochondriac contains :—1. The spleen. 2. The cardiac end of the stomach. 3. The left supra-renal capsule. 4. Part of the left kidney. 5. The splenic flexure of the colon.

II. The left lumbar contains :—1. The main part of the left kidney. 2. The descending colon. 3. Part of the small intestines. 4. Part of the great omentum.

III. The left iliac contains :—1. The sigmoid flexure. 2. Part of the small intestines. 3. Part of the great omentum.

C. In the middle line.

I. The epigastric region contains :—1. The main part of the stomach. 2. Part of the left lobe of the liver. 3. The pancreas behind. The transverse colon crosses between the epigastric and umbilical regions.

II. The umbilical region contains :—1. The small intestines in part, including the third portion of the duodenum. 2. Part of the great omentum.

III. The hypogastric region contains :—1. The small intestines in part. 2. Part of the great omentum. The uterus when gravid, and the bladder when distended, are also found in this region.

THE LOWER EXTREMITIES.

The all-important parts to know for clinical purposes in the extremities are the courses of the great blood-vessels, and the groups of muscles associated according to their nervous supply. Some account of femoral hernia will be given however, in the first place.

Femoral Hernia.—It happens, especially in females, that some one or more of the contents of the abdomen escape by the side of the femoral vessels. It will be found on examination that the femoral or crural sheath is, as it were, too large for the vessels contained therein, and in consequence a space is left. To this space the name

crural canal has been given. The canal is *funnel shape*, *three-quarters* of an inch in length; its upper, wider, or abdominal end is circular, and named the *crural ring*. The ring is shut across by a piece of sub-peritoneal tissue, constituting the *septum crurale*. On inserting the finger into the canal, the parts in relation will be found to be:—above, Poupart's ligament; below, the pubis; internally, Gimbernat's ligament; externally, the femoral vein, separated by a septum. It is down through this canal that a piece of, say, intestine comes enclosed in its sac of peritoneum. It first comes downwards, carrying with it the septum crurale; then comes forwards, distending the crural sheath; finds its way out at the saphenous opening in the fascia lata, and finally mounts up upon Poupart's ligament, having over it the deep layer of the superficial fascia, called the cribriform fascia, with the superficial fascia and skin. The *coverings* therefore are:—peritoneum, septum crurale, crural sheath, cribriform fascia, superficial fascia, and skin.

The arteries of the lower extremity are composed for the most part of the femoral artery and its continuations. The external iliac artery changes its name to the common femoral artery at Poupart's ligament.

The COMMON FEMORAL artery will be found to enter the thigh at a spot midway between the anterior superior spinous process of the ilium and the symphysis pubis. It has a course of about two inches, and then divides into superficial and deep. Its *relations* are: in front, superficial structures; behind, the psoas; internally, the femoral vein; externally, the anterior crural nerve about half an inch distant. The branches are: 1. Superficial circumflex iliac. 2. Superficial epigastric. 3. Superficial and deep external pudic.

THE SUPERFICIAL FEMORAL ARTERY.—When the leg is slightly flexed on the thigh, and the thigh on the abdomen, and the extremity slightly abducted, this artery will be found lying in the upper two-thirds of a line drawn from the point where the common femoral enters the thigh to the adductor tubercle. This tubercle is situated on the inner side of the inner condyle of the femur. In the upper part of its course the artery lies in Scarpa's triangle; in the lower, in Hunter's canal. It passes back through the opening in the adductor magnus, at the junction of the middle with the lower third of the thigh, to form the popliteal. The *relations* are: (*a*.) In Scarpa's triangle—

in front, superficial structures; behind, the vein; inside, the vein; externally, the branches of the anterior crural nerve. (*b*.) In Hunter's canal:—In front, skin, superficial fascia, fascia lata, Sartorius muscle, and a special aponeurosis over the vessel; to the outside, the vastus internus; to the inside and behind, the adductor longus muscle. In the canal with the artery there are also the vein and the internal saphenous nerve. The branches are:—1. Muscular. 2. Anastomotica magna.

The Deep Femoral, or Profunda Artery, comes also from the common femoral. It passes first to the outside of the superficial, but in the lower part of its course lies immediately behind it, separated by the adductor longus. Its *relations* are: in front, the superficial and deep femoral veins at the upper part; below, the adductor longus and the superficial femoral; behind, it rests on psoas, iliacus, pectineus, adductor brevis, and adductor magnus muscles. The branches are: 1. The internal circumflex, passes back between the psoas and pectineus, sends branches down to the adductor muscles, and appears posteriorly between the quadratus femoris and the adductor magnus. It gives off—(*a*) ascending; (*b*) descending; (*c*) communicating. 2. The external circumflex, passes outwards between the branches of the anterior crural nerve, and gives off—(*a*) ascending branches to gluteal region; (*b*) descending branches as far as the outside of the knee; (*c*) transverse branches. 3. Superior perforating. 4. Middle perforating. 5. Inferior perforating. 6. Fourth perforating or terminal. These vessels all perforate the adductor magnus, and one or two of them perforate the adductor brevis, to reach the hamstrings.

The Popliteal Artery lies in the popliteal space. The vessel reaches from the opening in the adductor magnus, down to the lower border of the popliteus muscle. The *relations* are: Behind, that is superficially, it has skin, superficial fascia, deep fascia (called here popliteal), the internal popliteal nerve, and the popliteal vein: in front, the lower end of the femur, the posterior ligament of the knee-joint, and the popliteus muscle covered by the popliteus fascia; the two last, the fascia and the ligament, are derived from the insertion of the semi-membranosus. On either side of the artery are the muscular boundaries of the space: externally, the biceps, the outer head of gastrocnemius and plantaris; internally, the semi-membranous, semi-tendinous, and the inner head

of gastrocnemius. The branches are: 1. Cutaneous. 2. Articular; two superior, two inferior, and an azygos 3. Muscular; an upper set supplying the lower end of the hamstrings, a lower set supplying the muscles of the calf. At the lower border of the popliteus muscle the popliteal artery divides into anterior and posterior tibial.

The POSTERIOR TIBIAL ARTERY is the direct continuation of the popliteal. It extends from the end of the popliteal down to the inside of the os calcis beneath the internal annular ligament, where it divides into internal and external plantar. The artery has: superficially, at the upper part, the muscles of the calf, at the lower part only cutaneous structures; deeply, it rests on the deep muscles, enclosed in a sheath derived from the deep fascia of the leg. Venæ comites accompany it. The nerve is first on the inside then passes over it to the outside. The branches are: 1. Peroneal. 2. Muscular. 3. Nutrient to the tibia. 4. Communicating to the peroneal. 5. Internal calcaneal.

The *Peroneal Artery* passes down in the substance of the flexor longus pollicis along the back of the fibula to the ankle, where it divides. The branches are: 1. Muscular. 2. Nutrient to the fibula. Terminal branches are: 3. External calcaneal. 4. The anterior peroneal passes forwards between the tibia and fibula below, pierces the interosseous membranes and anastomoses, with the tarsal artery on the dorsum of the foot.

The PLANTAR ARTERIES commence from the bifurcation of the posterior tibial, and run as their names imply. (*a.*) The internal passes along the inside of the foot, and gives off, cutaneous, muscular, anastomosing and periosteal branches. (*b.*) The external passes outwards towards the little toe between the first and second layer of muscles, then gets between the third and fourth layers of muscles to form the deep arch by anastomising with the dorsalis pedis. The branches are cutaneous, muscular, calcaneal, articular, periosteal, and plantar interosseous arteries.

The ANTERIOR TIBIAL ARTERY comes from the popliteal. It passes forwards over the top of the tibialis posticus muscle and the interosseous membrane, and runs down on that membrane between the tibialis anticus and the extensor longus digitorum above; then between the tibialis anticus and the extensor proprius pollicis, and finally between the extensor pro-

prius pollicis and extensor longus digitorum. The branches are: 1, recurrent tibial; 2, muscular; 3, internal and external malleolar. Venâ comites accompany it. The nerve lies on the outside and slightly to the front.

The DORSALIS PEDIS is the direct continuation of the anterior tibial artery. It runs forwards from the ankle, upon the astragalus, scaphoid, internal and middle cuneiform bones, and dips down between the first and second metatarsal to the sole of the foot, where it joins the deep arch. The guide to the vessel is the outer side of the tendon of the extensor proprius pollicis. The branches are: 1, tarsal; 2, metatarsal, giving off the dorsal interosseous arteries; 3, the dorsalis hallucis; 4, the arteria magna pollicis in the sole of the foot. Venæ comites accompany it. The anterior tibial nerve is to the outside.

The NERVOUS SUPPLY of the lower extremity is derived from the lumbar and sacral plexuses of nerves. For the formation of the plexuses *see* the Diagrams pages 26, 27.

A. The ANTERIOR CRURAL nerve enters the thigh beneath Poupart's ligament and between the psoas and iliacus muscles. It divides into cutaneous and muscular branches. *a.* Cutaneous branches are the middle and internal cutaneous, and the long or internal saphenous nerve. The last-named does not become cutaneous until it reaches the knee-joint, and then runs along the inside of the leg as far as the dorsum of the foot. *b.* The muscular branches supply the extensors of the knee, and the flexors of the hip—*i.e.*, the anterior group of muscles in the thigh. They are: 1, the rectus femoris; 2, vastus internus; 3, vastus externus; 4, crureus; 5, subcrureus; 6, iliacus, one branch inside and one outside the pelvis; 7, the pectineus, its outer half. The psoas is supplied by the lumbar plexus close to its origin.

B. The OBTURATOR NERVE comes from the lumbar plexus (3rd and 4th), runs down inside the psoas, and across the side of the true pelvis to gain the obturator foramen. It passes through the foramen, in a groove above the membrane, with the vessels. The nerve then divides into two main branches, superficial and deep. (*a.*) The superficial branch passes above the obturator externus, and then down the thigh between the adductor longus in front, and the brevis behind. It supplies: 1, the adductor longus; 2, the gracilis; 3, adductor brevis in part; 4, pectineus in part. (*b.*) The deep branch comes from the obturator foramen, through the obturator

externus, and passes down the thigh between the adductor brevis in front and the magnus behind. It supplies: 1, the obturator externus; 2, the adductor magnus; 3, the adductor brevis in part. The nerve now perforates the adductor magnus to reach the popliteal artery, by which it is conducted to the back of the knee-joint.

C. The GREAT SCIATIC NERVE supplies the muscles at the back of the thigh—the hamstring group. It emerges from the great sacro-sciatic foramen below the pyriformis muscle, runs down between the great trochanter of the femur and the tuberosity of the ischium, and finally lies between the hamstrings and the adductor magnus. It supplies: 1, the biceps; 2, the semi-membranosus; 3, the semi-tendinosus; 4, and a branch to adductor magnus. The nerve is continued down to the top of the popliteal space, where it divides into two—the internal and external popliteal.

I. The INTERNAL POPLITEAL nerve runs down the centre of the popliteal space close below the deep fascia, being the most superficial structure in the space. It gives off: *a*. Cutaneous branch—the external saphenous. This nerve becomes cutaneous halfway down the leg, and runs down along the outside of the foot to the little toe. *b*. Articular branches—two internal and an azygos, running along with the arteries of the same name. *c*. Muscular branches, five in number—two to the gastrocnemius, one to the soleus, to the popliteus, and to the plantaris muscles.

The POSTERIOR TIBIAL is the direct continuation of the internal popliteal. It runs down *on* the vessels to the inside of the ankle, where it lies on the outer side of the artery—viz., between the posterior tibial artery and the flexor longus pollicis. The branches given off supply: 1, the tibialis posticus; 2, the flexor longus pollicis; 3, the flexor longus digitorum; 4, the sole of the foot, by the plantar cutaneous branch.

The PLANTAR NERVES, the continuations of the posterior tibial nerve, are two in number, internal and external.

a. The *internal plantar nerve* runs along the inside of the foot, in a line parallel with the septum, between the abductor pollicis and the flexor brevis digitorum. It supplies: 1. *Two* muscles in the *first* layer, the abductor pollicis, and the flexor brevis digitorum. 2. *Two* muscles in the *second* layer, the two inner—*i.e.*, the first and second lumbricales. 3. The *two heads* of the flexor brevis pollicis in the *third* layer. 4. *Three and a half* inner toes.

b. The *external plantar nerve* runs outwards, and then forwards, along a line parallel with the septum between the abductor minimi digiti and the flexor brevis digitorum. It supplies all the muscles and toes in the sole of the foot not supplied by the internal: 1. In the *first* layer, the abductor minimi digiti. 2. In the *second* layer, the accessorius and the two outer (third and fourth) lumbricales. 3. In the *third* layer, the flexor brevis, minimi digiti, the transversus pedis, and the abductor pollicis. 4. In the *fourth* layer, the seven interossei muscles. The first and second layers are supplied by the superficial part of the nerve; the third and fourth, by the deep part of the nerve. It also gives a branch to supply *one and a half* outer toes—viz., the little toe and half the next.

II. The External Popliteal Nerve comes from the end of the great sciatic, passes down under cover of the inner edge of the biceps muscle, and gets finally round the head of the fibula to the front of the leg. It is said not to be within the popliteal space. *Before*, it winds round the head of the fibula, it gives off: 1. A cutaneous branch, the ramus communicans fibularis which runs down to join the external saphenous. 2. Articular branches, two external—superior and inferior; these run along with the arteries of the same name. The nerve now passes round immediately below the head of the fibula, between the peroneus longus and the bone, and there divides into anterior tibial and musculo-cutaneous.

1. The Anterior Nerve runs forwards beneath the extensor longus digitorum to reach the anterior tibial artery which it accompanies to the cleft between the first and second toes. It supplies: (1) the tibialis anticus; (2) the extensor proprius pollicis; (3) the extensor longus digitorum; (4) peroneus tertius; (5) extensor brevis digitorum; (6) the adjacent sides of the first and second toes.

2. The Musculo-Cutaneous Nerve runs down in the fascia between the peroneus longus and the extensor longus digitorum muscles, becomes cutaneous at the junction of the middle and lower thirds of the fibula, then passes over the anterior annular ligament to reach the dorsum of the foot. It supplies: (1) the peroneus longus; (2) the peroneus brevis; (3) branches to the toes; the branches to the toes are thus arranged: the nerve divides into two as it crosses the ankle; an *inner*

branch which supplies the inside of the big toe and the adjacent sides of the second and third toes: an *outer* branch, which supplies the adjacent sides of the third and fourth, and fourth and fifth toes.

THE ARTERIES OF THE UPPER EXTREMITIES

At their commencement the vessels of the two sides are not symmetrical, coming on the right side from the innominate, and on the left from the arch of the aorta. The arteries are the right and left subclavian.

The RIGHT SUBCLAVIAN ARTERY commences opposite the sterno-clavicular articulation on the right side, and ends at the outer border of the first rib. It is divided into three stages by the anterior scalene muscle.

I. The first stage extends from the sterno-clavicular articulation, and ends at the inner border of the anterior scalene muscle. It is about an inch long. The relations are: in front, the clavicle, sterno-hyoid and thyroid muscle, the internal jugular vein, the pneumogastric nerve, and cardiac branches of the sympathetic and pneumogastric; behind, the longus colli muscle; internally, the common carotid artery; externally and below, the pleura.

The *branches* are:—

1. The vertebral (*see* Head and Neck).
2. The internal mammary (*see* Thorax).
3. The thyroid axis; a thick trunk about $\frac{1}{4}$ inch in length which divides into:—

a. The *inferior thyroid* to the thyroid gland; the branches are: (α) laryngeal; (β) tracheal; (γ) œsophageal; (δ) ascending cervical.

b. The *transversalis colli* passes across the lower part of the neck just above the clavicle, and divides into (α) superficial cervical; (β) posterior scapular, which passes down the posterior border of the scapula, to anastomose with the subscapular and dorsalis scapulæ arteries, and with the following:—

c. The *transversalis humeri* passes across the lower part of the neck, below the vessel mentioned, to reach the supra-scapular notch. It is distributed in the supra-spinous and infra-spinous fossæ, and anastomoses with the other scapular vessels.

4. The *superior intercostal.* This vessel is sometimes described as coming from the second stage. It passes

down into the thorax, in front of the neck of the first rib, to supply the first part of the second intercostal space. It gives off: the *profunda cervicis*, which passes back between the neck of the first rib and the transverse process of the seventh cervical to anastomose with the arterio-princeps cervicis from the occipital.

II. The second stage of the artery lies underneath the anterior scalene muscle. It has: in front, the anterior scalene muscle and the scalene tubercle, the phrenic nerve, the subclavian vein, and the structures around the clavicle; behind, and above, the cords of brachial plexus; below, the pleura. It gives off no branches.

III. The third stage reaches from the outer border of the anterior scalene muscle to the outer border of the first rib. The relations are—in front, the clavicle, suprascapular artery, nerve to the subclavius, external jugular vein, and the subclavian vein; behind, and above, the cords of brachial plexus, and the middle scalene muscle; below, the first rib, and the first serration of the serratus magnus. It gives off no branches usually.

The Axillary Artery extends from the outer border of first rib to the lower border of the teres major. It runs along the outer and posterior wall of the axilla, and is divided into three stages by the pectoralis minor.

I. The first stage extends from the outer border of the first rib, to the upper border of pectoralis minor. The relations are—in front, the pectoralis major, the costo-coracoid membrane, the subclavian and cephalic veins; behind, and above, the cords of the brachial plexus; internally, the serratus magnus.

The *branches* are (*a*), the *superior thoracic*, going to first intercostal space; (*b*), the *acromio-thoracic*, giving off α, acromial; β, thoracic; and γ, descending branches with the cephalic vein.

II. The second stage corresponds to the breadth of the pectoralis minor. It has—in front, the pectoralis minor; internally and below, the vein; all around, the cords of the brachial plexus. The *branches* are—(*a*) *alar thoracic*, (*b*) the *long thoracic* or external mammary.

III. The third stage extends from the outer border of pectoralis minor to the lower border of the teres major. It has—in front, pectoralis major for a short distance, and beyond that the superficial structures only; behind, the subscapularis, the latissimus dorsi, and the teres major muscles; internally, the vein. The cords of the

brachial plexus are named outer, inner, and posterior, according to their relation with the artery. The *branches* are—(*a*) *anterior circumflex;* (*b*) *posterior circumflex;* these embrace the neck of the humerus, supplying muscular and articular branches; (*c*) the *subscapular* runs along the lower border of the scapula, and gives off the *dorsalis scapulæ* artery.

The Brachial Artery reaches from the lower border of the teres major to the neck of the radius.

The relations are—in front, skin, fascia with the bicipital fascia, the median nerve, and the median basilic vein; behind, the long and the internal head of the triceps, insertion of the coraco-brachialis, the brachialis, anticus, and the musculo-spiral nerve; internally, the ulnar nerve above, the median nerve below; externally, the biceps, the coraco-brachialis, and the external cutaneous and median nerves for a short distance above. Venæ comites accompany the artery. The artery lies at first on the inner side of the arm, but below lies directly in front. The *branches* are—

1. The *superior profunda* artery passes down with the musculo-spiral nerve to reach the external condyle of the humerus; there it divides into two branches, one of which anastomoses with the radial recurrent, the other with the interosseous recurrent.

2. The *inferior profunda* artery runs down with the ulnar nerve, to reach the back of the internal condyle, where it anastomoses with the posterior ulnar recurrent.

3. The *nutrient artery* to the humerus runs towards the elbow in the substance of the bone.

4. The *anastomotica magna* runs down with the median nerve to anastomose with the anterior ulnar recurrent.

All these vessels at the elbow anastomose with each other more or less directly; only the direct anastomoses have been given above.

The Ulnar Artery reaches from the ending of the brachial at the neck of the radius to the hand.

I. *In the fore-arm* the artery runs between the superficial and deep layers of muscles. In the upper part it runs beneath the sublimis, and upon the profundus digitorum. In the lower part it still lies upon the profundus, but immediately beneath the deep fascia. The guide to it at the lower part is the tendon of the flexor carpi ulnaris, on the outside of which it lies. The median nerve crosses it, and the ulnar nerve lies internal to it,

in the lower two-thirds of its course. The *branches* are—

1. The *anterior ulnar recurrent* artery anastomoses chiefly with the anastomotica magna.

2. The *posterior ulnar recurrent* runs up along the ulnar nerve to meet the inferior profunda.

3. The *interosseous trunk* divides into two—*a*. The *anterior interosseous* artery runs down on the interosseous membrane supplying the muscles on either side. It ends by passing back through the membrane to jointhe posterior interosseous. It gives off; *α*, muscular branches; *β*, nutrient arteries to the radius and ulna, these vessels pass upwards towards the elbow; *γ*, branches to anterior carpal arch. *b*. The *posterior interosseous* artery goes directly backwards between the two bones above the interosseous membrane, and appears posteriorly between the supinator brevis and the extensor ossis metacarpii pollicis. It passes down between the superficial and deep layers of muscles, receives the anterior interosseous artery, and finally joins the posterior carpal arch. The *interosseous recurrent* is the only named branch; it anastomoses chiefly with the superior profunda.

4. Anterior and posterior carpal arteries to the anterior and posterior carpal arches.

II. *In the hand*, the artery crosses the anterior annular ligament external to the pisiform bone, passes on to form the superficial palmar arch, and drops down a branch to complete the deep palmar arch.

1. The *superficial palmar arch* runs along the ball of the thumb beneath the palmar fascia, and there joins the superficialis volæ artery from the radial, thus completing the arch. The *branches* are—(*a*) muscular; and (*b*) digital. The digital arteries, three or four in number, receive communicating branches from the palmar interossei at the root of the fingers, and then divide into two to supply the adjacent sides of the fingers.

2. The *deep palmar arch* is formed by the radial artery, and the deep branch of the ulnar. It rests on the bases of the metacarpal bones. It supplies—(*a*) palmar interossei arteries; (*b*) perforating, to join the vessels on the dorsum; (*c*) muscular; and (*d*) articular.

The *anterior carpal arch* is formed by carpal branches from the radial and ulnar arteries; it lies on the lower end of the radius, and supplies the wrist.

The *posterior carpal arch* is formed by carpal branches

from the radial and ulnar arteries, and by the end of the interosseous arteries. It gives off the second and third dorsal interossei arteries.

The Radial Artery commences at the neck of the radius, and ends in the hand; it has three stages :—

I. *In the forearm* the artery lies upon, from above downwards, the tendon of the biceps, the supinator brevis, the pronator radii teres insertion, the flexor sublimis, the flexor longus pollicis, the pronator quadratus, and the radius. To the outside is the supinator longus and the radial nerve in the middle third; to the inside, the pronator radii teres above, and below the tendon of the flexor carpi radialis. The *branches* are :—1, *Radial recurrent* anastomosing with superior profunda; 2, *muscular;* 3, *superficialis volæ;* 4, *anterior carpal.*

II. *On the back of the wrist* the artery lies on the scaphoid and trapezium, and between the tendons of the primi and secundi internodii pollicis. The *branches* are :—1. *Posterior carpal;* 2, *first dorsal interosseous;* 3, *dorsalis indicis;* 4, *dorsalis pollicis.*

III. *In the hand,* the artery passes between the metacarpal bones of the thumb and forefinger, between the heads of the first dorsal interosseus muscle, and reaches the palm between the adductor pollicis and the flexor brevis pollicis, where it joins the ulnar to form the deep arch. The *branches* are :—1, *Princeps pollicis;* 2, *radialis indicis;* 3, *palmar interossei;* 4, *perforating,* to pass back between the metacarpal bones to join the dorsal interossei.

The Veins in the upper extremity accompanying the arteries are venæ comites as high as the axilla. The superficial veins commence at the hand and wrist as three sets :—An external, the *radial*; an anterior, the *median;* and an internal, the *ulnar.* The median divides at the bend of the elbow into the—1, *median basilic* branch, which, on being joined by the ulnar veins, is called the *basilic;* and 2, the *median cephalic,* which, on being joined by the radial, is called the *cephalic.* The basilic vein pierces the fascia half way up the arm and joins the brachial; the cephalic runs up between the deltoid and pectoralis major, and pierces the costo-coracoid membrane to reach the axillary.

THE NERVES OF THE UPPER EXTREMITIES are derived from the brachial plexus. This plexus is formed by the anterior primary divisions of the fifth, sixth, seventh, and eighth cervical, and first dorsal nerves. The fifth and sixth unite to form a trunk, which is joined by the seventh; the eighth cervical and first dorsal join to form a cord, so that, as the plexus passes beneath the clavicle, there are only two cords. Beneath the pectoralis minor, however, the cords divide into three terminal branches, forming the outer, posterior, and inner cords of the brachial plexus (*see* Diagram, page 25).

A. *Above the clavicle* the branches are :—*The nerves to the rhomboid and subclavius* muscles from the fifth; the *posterior thoracic*, or nerve of Bell, from the fifth and sixth, supplies the serratus magnus; the *supra-scapular* from the cord formed by the fifth and sixth supplies the supra-spinatus and infra-spinatus muscles.

B. As the two cords pass *beneath the clavicle*, a branch from each unites to form an arch across the axillary vessels, and from this the internal and external anterior thoracic, which supply the *pectoralis major and minor*, are derived.

C. *Beneath the pectoralis minor* the cords resolve themselves into three—one to the outside, a second to the inside, and a third behind the axillary artery.

I. The outer cord of the plexus gives off—1. The external cutaneous, called also the musculo-cutaneous or, from the fact of its perforating the coraco-brachialis muscles, the perforans Casserii, supplies three muscles :—(*a*) *the biceps;* (*b*) *the coraco-brachialis;* and (*c*) *the brachialis anticus.* It becomes cutaneous about two inches below the elbow-joint, and ends on the ball of the thumb. 2. The outer head of the median (*see* Median Nerve).

II. The inner cord gives off the following :—1. The ulnar nerve passes down the inside of the axillary and brachial arteries, and gets behind the internal condyle of the humerus. There it passes between the heads of the flexor carpi ulnaris, joins the ulnar artery at the middle-third of the fore-arm, and accompanies the artery to the hand. The branches given off are :—In the *fore-arm* (*a*) *cutaneous*, a small palmar cutaneous branch; (*b*) *articular*, to the elbow-joint; (*c*) *muscular*, to the flexor carpi ulnaris and half the flexor profundus digitorum; (*d*) the *dorsal cutaneous* passes to the back of the hand to supply

the fifth and half the fourth finger. In the *hand* the nerve divides into superficial and deep branches accompanying the arteries. The branches supplied are—*digital,* to the anterior aspects of the fifth and half the fourth finger. The *muscular* branches are—(*a*) To the muscles of the *little finger*—the abductor, the flexor brevis, and the opponens minimi digiti; (*b*) to the two *inner lumbricales* muscles; (*c*) to the dorsal and palmar *interossei* muscles; (*d*) to the muscles of *the thumb*—the adductor pollicis and half the flexor brevis pollicis.

2. The internal cutaneous nerve becomes cutaneous two inches above the elbow-joint, it lies superficial to the veins at the bend of the elbow, and supplies the skin as low as the wrist.

3. The lesser internal cutaneous—the nerve of Wrisberg—ends on the inner side of the arm.

4. The inner head of the median crosses the axillary artery to join the outer head from the outer cord. The *median nerve,* formed on the outer side of the axillary, passes across the brachial artery opposite the middle of the arm, and lies on its inner at the bend of the elbow. It then disappears between the deep and superficial layers of muscles in the fore-arm, and passes beneath the annular ligament to the hand. In the *arm* it supplies no branches. *In the fore-arm* it gives off the *anterior interosseus,* along with which it supplies all the muscles in the front of the fore-arm—viz., the pronator radii teres, palmaris longus, flexor carpi radialis, flexor sublimis digitorum; and (by the anterior interosseous branch) the flexor longus pollicis, half the flexor profundus digitorum, and the pronator quadratus. *At the wrist,* a palmar cutaneous branch. *In the hand* it supplies—(*a*) *digital* branches to three and a half outer fingers on their palmar aspects; (*b*) *muscular* to the abductor pollicis, to the opponens pollicis, to half the flexor brevis pollicis, and to the two outer lumbricales.

III. The posterior cord of the plexus gives off—In the axilla:—1. The three subscapular to the subscapularis, latissimus dorsi, and teres major muscles. 2. The circumflex, passing through the quadrilateral space behind the humerus, to supply the deltoid and teres minor muscles. 3. The musculo-spiral nerve occupies the groove of that name behind the humerus.

In the arm the nerve is divided into three stages, according to its relations to the musculo-spiral groove

and triceps muscle. *Before* it enters the groove it gives off one cutaneous branch to the inside of the arm, and two muscular branches to the triceps. *In* the groove it gives off two muscular branches, one to the triceps, the other to the anconeus. *After* it emerges from the groove, the nerve lies between the supinator longus and the brachialis anticus, where it supplies two cutaneous branches, and two muscular, to the supinator longus and extensor carpi radialis longior. Opposite the neck of the radius the nerve divides into two—the radial and posterior interosseus. (*a.*) The *radial* nerve passes down the forearm, touching the radial artery only in the middle third of the forearm, and gets beneath the tendon of the supinator longus to supply three and a half fingers on the back of the hand. (*b.*) The posterior interosseous nerve passes back through the supinator brevis muscle, runs down the back of the forearm supplying all the muscles there, and ends in a gangliform enlargement at the back of the wrist. The muscles supplying it are—the extensor carpi radialis brevior, the extensor communis digitorum, extensor minimi digiti, the supinator brevis, extensor ossis metacarpi pollicis, extensor secundi internodii pollicis, extensor primi internodii pollicis, and the extensor indicis.

To group the nerve supply of the lower and upper extremities the following may be useful:—

A. In the Lower Extremity:—1. In the Thigh there are *four* groups of muscles and *four* sets of nerves. The *extensor* group is supplied by the *anterior crural;* the *adductor* group, by the *obturator;* the *flexor* group by the *great sciatic;* and the *abductor* group by the *gluteal.* 2. In the Leg there are three groups of muscles, and three sets of nerves:—an anterior or *extensor* group supplied by the *anterior tibial* nerve; an external or *peroneal* group supplied by the *musculo-cutaneous* (these are both branches of the external popliteal); and a posterior or *flexor* group supplied by the *posterior* tibial nerve, (a branch of the internal popliteal which also supplies the muscles of the calf of the leg).

B. In the Upper Extremity:—1. In the Arm there are *two* groups of muscles and *two* nerves supplying them. The *anterior* group, consisting of the coraco-brachialis, brachialis anticus and biceps, is supplied by the *external* or *musculo-cutaneous* nerve. The *posterior* group, consisting of the triceps and anconeus muscles, is supplied by the *musculo-spiral* nerve. 2. In the Forearm there are *four* groups of muscles and *four* sets of nerves supplying them. The *anterior* group supplied by the *median* and its branch the anterior interosseous. The *external* group, consisting of the supinator longus and extensor carpi radialis longior, supplied by the *musculo-spiral.* The *internal* group, consisting of the flexor carpi ulnaris and half the flexor profundus digitorum, by the *ulnar* nerve. The *posterior* group, by the *posterior interosseous*, a branch of the musculo-spiral.

PART II.

PRINCIPLES OF CHEMISTRY AND CHEMICAL PHYSICS.

The chemistry of the materials used in medicine is the only part of chemistry dealt with in this compendium.

As an introduction to the right understanding of chemistry, physics require to be mastered, and consequently a short account of the principles of physics is given as an introduction.

A *new system* is adopted in the arrangement of the salts used, as also in the history of an element. Thus, the *source* of the metal is first given; the *means by which the element is abstracted* are then described; the different *preparations are arranged as they are prepared from each other.* Take, for example, *lead,* and consider the headings given. The *letters* and *figures* are put not to *indicate number only, but position and importance.*

First, the source and abstraction of the element are given, and then the salts and preparations arranged in order of derivation.

LEAD.

The *source* of lead salts is galena—*i.e.,* lead sulphide—PbS. By roasting this salt—

A. Lead, Pb, is obtained. From hence :—

I. Plumbi oxidum is prepared. From hence :—

1. Plumbi acetas, by adding acetic acid to the oxide.

Preparations of the acetate are :—

(*a.*) Unguentum plumbi acetatis, &c.

(*b.*) Pilula plumbi cum opio.

From hence—*i.e.,* the acetate—is derived :—

1. Liquor plumbi subacetatis.

Preparations :—

(*a.*) Liquor plumbi subacetatis dilutus.

(*b.*) Unguentum plumbi subacetatis compositum.

II. Plumbi Carbonas. A large II. is here used to indicate that the original source, *lead*, is gone back to.

Preparation:—(*a*.) Unguentum plumbi carbonatis.

III. Plumbi Nitras. A large III. is here used to indicate that the original source, lead, is again gone back to. Hence:—

1. Plumbi iodidum.

Preparations:—(*a*.) Emplastrum plumbi iodidi.
(*b*.) Unguentum plumbi iodidi.

It will be seen in this list that the numbers indicate whence any given salt is derived. I., II., III., indicate that the source is gone back to. 1, 2, &c., and letters of the same size, indicate that they are derived from salts with numbers I., II., III. Then again, derived from 1, 2, &c., we have salts with numbers (i.), (ii.), &c., and from these again we have to use Greek initials, α, β. The letters of the alphabet, *a*, *b*, *c*, &c., are used to indicate preparations.

ATTRACTION AND AFFINITY.

The action of these two natural agencies lies at the foundation of chemistry and chemical properties. Attraction is of various kinds.

1. The attraction of gravitation, whereby masses of matter are drawn together. This is the general cause of position and weight. Weight signifies the force with which a given quantity of matter is attracted towards the earth's centre.

2. The attraction of cohesion, whereby the particles of any given mass of matter are united together, rendering it hard, soft, &c.

3. The attraction of adhesion, whereby various substances have the power of adhering to each other. *Capillary* attraction is one variety of heterogeneous adhesion; it signifies the power which fine tubes or porous substances have of imbibing liquids.

4. Chemical attraction, whereby particles of dissimilar matter exert influence on each other at insensible distances; which means that, in order to produce chemical action two or more bodies of dissimilar nature must be present, and must be in close approximation, as chemical force does not act at a distance like gravitation.

Chemical attraction is sometimes called *affinity*. When *two* bodies which have a chemical attraction for each other are mixed together and combine—sulphuric acid and magnesia for instance—it is said to be a case of *simple affinity*.

Affinity is exerted with different degrees of force between different bodies—*i.e.*, some have far more mutual attraction than others. Thus, sulphuric acid and ammonia attract each other more forcibly than carbonic acid and ammonia.

If, therefore, sulphuric acid be added to a combination of carbonic acid and ammonia, it seizes the ammonia, and expels the carbonic acid. This is said to be a case of *single elective affinity*; *elective*, because the sulphuric acid is, as it were, *chosen* by the ammonia in preference to the carbonic. It is also said to be a case of simple *decomposition*, the *compound* of carbonic acid and ammonia being separated or *de*composed by the sulphuric acid.

When two bodies, each composed of two others, are put together, there may occur what is called *double decomposition*, in consequence of *double elective* affinity. Thus, let there be mixed together one compound of iodine and potassium (called iodide of potassium) and another of chlorine and mercury (called bichloride of mercury); here there occurs a double interchange, the chlorine passes from the mercury to the potassium, and the iodine from the potassium to the mercury.

It was previously remarked that chemical attraction takes place only at insensible distances; hence it is promoted by whatever tends to divide matter most minutely, and to bring its particles into closest contact, especially mechanical *division* and *solution*. It is opposed by whatever tends to harden bodies, or to remove them from each other.

Chemical action is generally evidenced by certain phenomena. *Heat* and *light* are very common attendants on rapid and energetic chemical action; *change of form*, from solid to liquid, or æriform, or the reverse, is also very common; but the most reliable test of chemical action is the production of a *new compound*.

Hence the chemical combination of two bodies is very different from a mechanical mixture.

When two bodies are merely mixed mechanically, each retains its properties, although in a modified form. Thus, brandy and water, or sulphuric acid and water, may be

mixed in any proportions, but each ingredient still exhibits its distinctive qualities, although weakened or mitigated.

But when two bodies *combine chemically*, each loses its own properties, and a new body is formed quite unlike either of its constituents. Thus, sulphuric acid and magnesia when combined, form sulphate of magnesia, in which not a trace can be detected of either sulphuric acid or of magnesia by sight, touch, smell, or taste.

The terms *Synthesis* and *Analysis* are frequently used in chemistry; the former denotes the combining or uniting of substances; the latter, their decomposition or separation.

ATOMIC THEORY.

From the behaviour of chemical substances whilst acting one upon the other, chemists, led by Dalton, have been driven to accept the theory that matter is made up of indivisible portions called atoms. Atoms possess different weights, but the relation between their weights is represented by that of the combining weights of the elements. The bulk occupied by individual atoms is assumed to be the same, but as a single atom can exist only in combination, the molecule, or two atoms, is the smallest portion assumed to exist in a free state. Thus, the atom of oxygen is represented O, but as that cannot exist by itself, it is written OO or O_2, to represent the molecule or two atoms. Dalton was enabled to explain the laws of chemical combination, previously in existence, by the atomic theory. These laws were :—

1st. The law of *constant* proportions—that is, that a definite compound, say water, always contains the same elements in the same proportions.

2nd. The law of *multiple* proportions—that is, that two elements, uniting in more than one proportion, do so in simple multiples. Thus, CO, carbonic oxide, is 12 of carbon and 16 of oxygen; but CO_2 is 12 of carbon and 32 of oxygen, oxygen uniting as 16, or multiples of 16, but in no intermediate numbers.

3rd. The law of *reciprocal* proportions—that is, that the proportions in which either of two bodies unites with a third are the proportions in which they unite with each other.

1. The *weights* of the atoms are represented by the

smallest proportion in which they migrate from compound to compound. Thus, hydrogen moves as 1, and this is taken as the standard weight; oxygen as 16, nitrogen as 14. By actually weighing different volumes of gases, and by finding out by weighing the loss or gain which ensues in individual instances where change occurs, we can determine the atomic weights of most of the elements.

2. Atoms differ in *value*. Hydrogen is again the standard of comparison. Oxygen, in relation to hydrogen, is said to be bivalent, or double its worth. By this it is meant that oxygen can replace two atoms of hydrogen, or that it requires two atoms of hydrogen to saturate one atom of oxygen. Dashes are used to represent this. Thus:

$H'Cl'$	are univalent,
$O''S''$	are bivalent,
N'''	is trivalent,
C''''	is quadrivalent,

So with each element it would be correct to write the quantivalence, as it is called, thus:

$$H'Cl'. \quad H'_2O''. \quad C''''H'_4. \quad C''''O''_2.$$

Thus the symbol H' represents an atom of hydrogen, univalent, or capable of replacing one atom of another monatomic element.

OXYGEN. O. 16.

Oxygen was first prepared from red oxide of mercury, but is now more cheaply prepared by heating chlorate of potassium. In order to collect the gas, the salt is placed in a glass flask; a bent tube leads from the neck of the flask to a trough containing water. The bubbles of gas are collected in jars filled with water, and placed with their mouths downwards in the trough. If black oxide of manganese be added to the chlorate of potassium, the evolution of the gas is facilitated.

Properties.—Colourless, tasteless, inodorous; supports combustion, and unites with metals, forming oxides, acids, alkalies, &c. All bodies which burn in the air, burn with increased brilliancy when plunged into a jar of oxygen gas. Oxygen is the great support of animal life; animals inhale air to get the oxygen contained in it, and exhale

carbonic acid. Plants decompose carbonic acid, fixing the carbon in their substance, and setting the oxygen free to be used by animals.

Oxygen exists in an allotropic condition, called *ozone*. If a series of electric discharges be passed through pure oxygen, the gas becomes diminished in volume by about one-twelfth, and is partly transformed into ozone. Many ascribe all the active life-supporting properties of oxygen to ozone, and represent it by formula O_3. Oxygen has been tried in medicine in cases of apnœa and dyspnœa, but with anything but marked effects.

The further chemical history of oxygen is found under the headings "Air" and "Water," and in every important mineral and vegetable compound.

NITROGEN. N. 14.

Nitrogen is found in a free state in the air, in combination in many salts, and in the animal and vegetable tissues. It is best prepared by burning phosphorus in a bell-jar filled with air and inverted over water. One-fifth of the volume of the air disappears, the water rising in the jar to that extent, and the remaining four-fifths consists of nitrogen. Nitrogen is also prepared by passing air over red-hot copper; or by passing chlorine gas over ammonia.

Properties.—Nitrogen is chiefly passive, it neither supports combustion nor does it burn. It is colourless and tasteless, and a little lighter than air. It acts in the air as a diluent to the oxygen.

The further accounts of nitrogen are found under "Air," and also many chemical reactions.

HYDROGEN. H. 1.

Hydrogen gas may be prepared from water. Two-thirds of the bulk of water is formed by it, and the remaining one-third of oxygen; it can be separated from the oxygen in various ways. If potassium or sodium be wrapped in a piece of wire gauze, and held beneath the mouth of a cylinder filled with and inverted over water, hydrogen gas is liberated and collected. The gas can also be obtained by passing steam through a red-hot gun barrel. The usual way of obtaining hydrogen in the laboratory is

by putting some zinc clippings into a flask provided with a perforated cork, and pouring therein sulphuric acid and water.

Properties.—Hydrogen burns in the air with a slightly luminous flame, producing steam. It does not support combustion. It is considerably lighter than air.

The properties of hydrogen, and its value in Nature and in the laboratory, is discussed under "Water," and many other substances throughout the book.

ATMOSPHERIC AIR.

The earth is everywhere surrounded by a mass of gaseous matter, called the atmosphere, which is retained at its surface by the force of gravity, and revolves with it around the sun. It is colourless and invisible, has neither taste nor smell when pure, and its presence is insensible except when it is in motion. Weight of 100 cubic inches 31·0117 grains. At 62° F. it is 815 times lighter than water. Its pressure at the level of the sea is equal to a weight of about 15 pounds on every square inch of surface, and is capable of supporting a column of mercury 30 inches high, and one of water of 34 feet.

The construction of the *barometer* is founded on the fact that the atmosphere, supposing its density to be uniform, is capable of supporting in a glass tube a column of mercury 30 inches high, at the level of the sea. Owing to causes not at present understood, the pressure of the atmosphere varies at the same place; hence the indications of the barometer as a weather-glass; for it has been well ascertained, that when the weather is dry and calm the barometer is high, but when wet and stormy the mercury falls. Atmospheric pressure diminishes as we rise above the level of the sea, and on this principle the altitude of mountains is estimated; a fall of one inch in the barometer corresponds to 11,065 inches, or 922 feet of elevation.

From calculations founded on the phenomena of refraction, the height of the atmosphere is supposed to be about 45 miles.

Composition.—By weight, nitrogen 77; oxygen 23=100. By volume, nitrogen 4-5ths; oxygen 1-5th.

The atmosphere also contains aqueous vapour and

carbonic acid, the latter in the proportion of 4 parts in 10,000. The odoriferous matter of flowers, ammonia, and other volatile substances, are also frequently present.

Carbonic acid has been found in the atmosphere at all altitudes yet attained; its proportion is greater in summer than in winter, and its relative quantity is diminished after much rain, owing, perhaps, to the direct absorption of it by the moist ground.

The chief vital and chemical properties of the atmosphere are dependent on the oxygen which it contains. The uses of nitrogen have not been ascertained, but it has been generally supposed to act as a mere diluent to the oxygen. The atmosphere is a mere mechanical mixture of its constituents, and not a chemical combination.

The gases of air, in common with other gases, have the power of becoming intimately mixed, even when differing in their weight and specific gravity. This process is allowed for by the *diffusive power of gases.* The rate varies with the specific weight or volatility of each gas. Thus hydrogen diffuses more quickly than carbonic acid gas. By experiment the following law has been established: *that the velocity of diffusion of different gases is inversely proportional to the square roots of their densities.* Thus, four volumes of hydrogen will pass through a piece of plaster, or stucco, in the same time as one volume of oxygen, oxygen being sixteen times heavier than hydrogen. This property of gases provides for the carrying off of the carbonic acid we exhale, and the supplying us with air consisting of proper proportions of oxygen and nitrogen.

The composition of the air can also be determined by the *eudiometer* (*see* Water). Into the inverted mercury tube introduce a small quantity of air, then generate hydrogen in the usual way, and conduct it beneath the mouth of the tube as it stands in the mercury trough. On passing an electric spark, the oxygen in the air unites with the hydrogen, water is formed, and the mercury rises in the tube, showing a diminution in the bulk of the gas. The gas left is nitrogen with whatever excess of hydrogen may have been introduced. By careful experiment, the proper quantity of hydrogen need only be used; if so, the nitrogen will be found to form 4-5ths of the previous volume of gas in the tube.

Gases also expand by heat.—By experiment it has been

found that all gases expand $\frac{1}{273}$rd part of their volume, at 0° C. for every increase in temperature of 1° C. Thus 273 volumes of any gas at 0° C. will become 274 at 1° C. and so on. This fraction is practically the same for all gases, and is called the *co-efficient of the expansion of gases.* Gases are also affected by *pressure,* expanding or diminishing in bulk, according as they are subjected to much or little pressure. From this fact Boyle's or Marriotte's law is deduced, viz.,—*That the volume occupied by any gas is inversely proportional to the pressure to which it is subjected.* To understand this, it is plain that *one* volume under a certain pressure will become *two* volumes when only *half* that pressure is employed; or it will become *one-half* when double the pressure is used.

HEAT.

Heat may exist in two different forms: in a state of freedom, sensible heat; or in a state of combination, latent heat. Heat is communicated from a hot body to others which are colder, in two ways, by *conduction* and by *radiation;* by the former, when a hot body touches a cold one, so that the heat travels along directly from one to the other; by the latter, when the heat passes off from the heated body to others at a distance. Both conduction and radiation depend on the tendency heat has to diffuse itself among all bodies, until an *equilibrium of temperature is established.*

Heat passes through different bodies with different degrees of velocity, some substances offering very little impediment to its progress, whilst others transmit it slowly. Owing to these facts, bodies are divided into CONDUCTORS and NON-CONDUCTORS of heat.

Metals are the best conductors of heat.

Liquids are but imperfect conductors of heat, in the strict sense of the term, although they are capable of transmitting it very readily by their particles. When heat is applied to the under surface of a vessel containing water, two currents are immediately established in the liquid; the one, of hot particles rapidly rising towards the surface, the other, of colder particles descending to the bottom. This transmission of hot particles is termed the *convection* of heat.

When heat is made to enter at the upper surface of a liquid, it is very slowly transmitted to the lower part.

Take a long test tube filled with water, and one may boil the water in the upper part of it by means of a spirit-lamp, whilst the bottom continues quite cold; but if one applies the lamp to the bottom of the tube, the heated water rises to the top, and makes the whole warm. Thus is seen the difference between *conduction* and *convection;* the particles of a conductor—an iron poker for instance—allow the heat to travel through them; whilst the particles of a column of water, or air, shift their places, and *convey* the heat with them.

The solid bodies that are the worst conductors of heat are, wood, charcoal, fur, hair, feathers, cotton, wool, and all substances of a light, porous texture; but their non-conducting properties are probably owing to the air which they contain in their pores.

Radiation of Heat.—The great source of *radiant* heat is the sun.

Heat is emitted from the surface of a hot body equally in every direction, and in right lines, like radii drawn from the centre to the surface of a sphere. When the rays thus emitted fall on a solid or liquid substance, they may be disposed of in three different ways:—

1. They may be *reflected;* 2, they may be *absorbed;* and 3, they may be *transmitted* through it.

In the first and third case, the temperature of the body on which the rays fall is not affected; whereas in the second it becomes materially so.

The radiation of heat by hot bodies is influenced in a very marked degree by the nature and colour of their surfaces. To demonstrate this by experiment, let a canister of polished block tin, forming a cube of six or eight inches be provided, having a tube at the middle of its upper side, from half an inch to an inch in diameter, and the same in height. This orifice is intended to receive a cap having a small hole, through which a thermometer is inserted, so that its bulb may reach the centre of the canister. Let one side of the canister be covered with black paint; by scratching with sand-paper, destroy the polish of another side; tarnish a third with quicksilver; and leave the fourth bright. The vessel is now to be filled with boiling water. The radiation of heat is greatest from the blackened side, less from the tarnished or scratched side, and least of all from the polished side.

A bright, smooth, polished plate of metal radiates heat very imperfectly; but if its surface is in the slightest

degree dull or rough, the radiating power becomes augmented. It follows from this, that the velocity and power of radiation depends more on the *surface* than the *substance* of a radiating body. Polished gold, silver, tin, brass, &c., are bad radiators of heat; but the same metals become good radiators if their polish and smoothness become destroyed.

Those surfaces which reflect *light* most perfectly are not equally adapted to the reflection of heat. For example: a glass mirror, which reflects light with great effect, when held before a blazing fire scarcely returns any heat, although the mirror itself becomes warm. On the contrary, a polished plate of silver, tin, or brass—metals which are little prone to receive heat from other sources, but which retain their own heat—reflect to the hand a very considerable degree of warmth. Thus it is proved that metals are much better reflectors of heat than glass, and that they possess this property in a higher degree in proportion to the perfection with which they are polished.

The best reflectors of heat will *absorb* the least heat; or in other words, surfaces are endowed with various powers of reflecting heat, and their power of absorbing heat is in the inverse ratio of their reflecting power. Those surfaces which *radiate* best, will absorb heat most readily.

Measurement of Heat.—*Fahrenheit's Thermometer.*—This is the one generally employed in this country. The first object in constructing the instrument is to obtain a glass tube with a very small bore, which is of the same diameter throughout its length. On one end of the tube let the neck of an elastic bottle be firmly tied, and let the other end be heated by the flame of a blowpipe until the glass softens. The softened part must then be pressed, by a clean piece of metal, into the form of a rounded button, and to this the flame of a lamp should be steadily applied till it acquires a white heat, and seems about to enter into fusion. To prevent it falling on one side, the tube during the process must be constantly turned round by the hand. When the heated part appears quite soft, remove it quickly from the lamp, and, holding the tube vertically, with the elastic bottle uppermost, press the latter gently with the hand. By this means a bulb will be formed. Mercury is now introduced by rarefying the air in the bulb by means of heat, and th n dipping the open end of the tube into a saucer of clea quicksilver. As the air cools and contracts, the

mercury is forced up, and, entering the bulb, supplies the place of the air which has been expelled from it. A portion of air however remains; this is expelled by boiling the mercury. The bulb and one-third of the tube being full of the mercury, the next step is to seal the open end hermetically. This is done by heating the bulb of mercury till it comes up completely to the top of the tube, and then darting a fierce flame across the tube to melt it and seal it up. Thus the tube is closed, and the air quite excluded.

The next stage of the process is to graduate the instrument; and in order to effect this, the first step consists in obtaining fixed points. The freezing-point of water is ascertained by immersing, in melting snow or ice, the bulb and part of the stem, so that the mercury when stationary shall barely appear above the surface. At this point a mark should be made with a file. In order to ascertain the boiling-point much more precaution is requisite. The directions generally given are; that the water be perfectly pure, free from foreign bodies, and not above an inch in depth; the ebullition brisk, and conducted in a deep metallic vessel, so that the stem of the thermometer may be surrounded by an atmosphere of steam; that the vapour be allowed to escape freely; and that the barometer stand at thirty inches. Having obtained the boiling-point, another mark is to be made. The intermediate space between these two points, the lowest being called 32°, and the highest 212°, is to be divided into 180°.

Continental physicists employ either the Centigrade or Reaumur's scale. The Centigrade is the most convenient in practice; its boiling-point is 100, that of melting ice its zero, and the interval is divided into one hundred equal parts. The space in Reaumur's is divided into eighty parts; 80 being the boiling-point.

Thermometric Scale (from Attfield's "Chemistry").—Formula for the conversion of degrees of one thermometric scale into those of another :—

F., Fahrenheit.	R., Reaumur.
C., Centigrade.	D., The observed degree.

If above the freezing-point of water (32° F.; 0° C.; 0° R.):

F. into C. . . .	(D. − 32) ÷ 9 × 5.
F. ,, R. . . .	(D. − 32) ÷ 9 × 4.
C. ,, F. . . .	D. ÷ 5 × 9 + 32.
R. ,, F. . . .	D. ÷ 4 × 9 + 32.

If below freezing-point, but above 0° F. (−17·77° C.; −14°·22 R.):

F. into C.	. . . .	− (32 − D.) ÷ 9 × 5.
F. ,, R.	. . . .	− (32 − D.) ÷ 9 × 4.
C. ,, F.	. . .	32 − (D. ÷ 5 × 9).
R. ,, F.	. . .	32 − (D. ÷ 4 × 9).

If below 0° F. (− 17·77° C.; − 14·22° R.):

F. into C.	. . . .	− (D. + 32) ÷ 9 × 5.
F. ,, R.	. . . .	− (D. + 32) ÷ 9 × 4.
C. ,, F.	. . . .	− (D. ÷ 5 × 9) + 32.
R. ,, F.	. . . .	− (D. ÷ 4 × 9) + 32.

For all degrees:

C. into R.	. . .	D. ÷ 5 × 4.
R. ,, C.	. . . .	D. ÷ 4 × 5.

Latent Heat (*see* Water).

Specific Heat.—This term signifies that different substances of equal weights have their temperatures raised unequally by the same degree of heat; in fact, the same amount of heat which would raise a known quantity of water one degree, would raise the same quantity of oil 2° and of mercury 29°.

Frigorific Mixtures.—When bodies expand, or liquefy, or evaporate, heat is absorbed or made latent—*i.e.*, cold is produced. When, on the contrary, a vapour is condensed into a liquid, or a liquid into a solid, heat is given out. Advantage is taken of these principles in forming mixtures for the purpose of producing cold. These may be formed of ice, or snow and salt, or snow and dilute sulphuric acid, or a mixture of neutral salts with water; and it is found that the ice and salt in dissolving absorbs considerable heat—*i.e.*, generates considerable cold. Two parts of ice pounded to one of salt, or equal weights of saltpetre and sal-ammoniac, with water enough to dissolve them, are active frigorific mixtures.

Effects of Heat.—The general effects of heat are, expansion, liquefaction, vaporization, spontaneous evaporation, and ignition.

Expansion.—The bulk of bodies is increased when their temperature is augmented. This is supposed to be owing to the heat insinuating itself between the particles of the substance, and thus separating them more or less from each other. The degree of expansion is in the direct ratio of the increase of temperature, and the expanded body returns to its former size when its temperature is reduced.

The ratio of expansion is greater in gases than in liquids, and least in dense bodies. *Exceptions.*—Water, in passing from 37·5° F. to 32° F., expands. The other liquids which expand under diminution of temperature are fused iron, zinc, antimony, and bismuth. This expansion, however, is said to be owing to the particles of the liquid arranging themselves in a new form when about to become solid.

Liquefaction.—Almost all solids are capable of being liquefied when their temperature is sufficiently increased. It is supposed that the heat acts by diminishing the cohesion of their particles, and thus allowing them to move freely on each other.

Ebullition.—This term is used to denote the rapid conversion of a liquid into an aëriform state, as when water is converted into steam by boiling. The degree at which liquids boil depends on the atmospheric pressure on their surface. Water, on high mountains, where the weight of the atmosphere is little, boils at a very low degree; in fact, the boiling point sinks one degree for every 530 feet of ascent. Increase the pressure on the surface of the liquid sufficiently, however, and the liquid may be heated to almost any degree without boiling.

Spontaneous Evaporation.—Many liquids, and indeed solids, readily pass into the state of vapour, or volatilize at the ordinary temperature. Alcohol, ether, and water form examples of the former, while carbonate of ammonia, iodine, and bromine may be adduced as those of the latter.

Ignition.—When a substance is exposed to a sufficient heat to cause it to become luminous, and at the same time to radiate heat, without undergoing any marked chemical change, it is said to be in a state of ignition. Wedgwood fixed the point at which this takes place at 947,° others place it between 672° and 790°.

The sources of heat are generally reduced to six: 1, The sun; 2, combustion; 3, electricity; 4, animal heat; 5, chemical action; 6, mechanical action; combustion and animal heat may both be ranked, however, under the head of chemical action.

Very high temperatures used to be ascertained by instruments called *pyrometers*; but the contrivances invented by Wedgewood, Daniell, and others have gone completely out of use. No accuracy could be got by such instruments. The arrangements now used are either

based on the expansion of gases, or on the electric properties of bodies.

LIGHT.

Two theories of light are entertained, the *corpuscular*, according to which light is regarded as a material actually impinging upon the retina, and the *undulatory*, according to which light is supposed to excite movements in the media in contact with the retina.

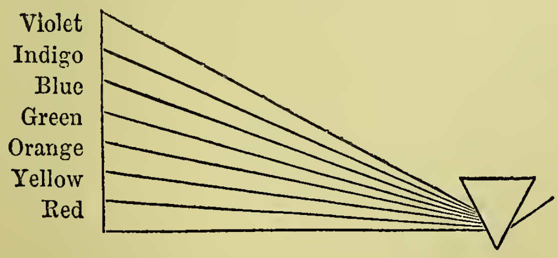
When light falls on a *plane* transparent surface, it passes through without deflection; when it falls on a *convex* mirror, parallel rays are rendered divergent; and when it falls on a *concave* mirror, parallel rays are made to converge. The convergent rays meet at a point situated midway between the centre and the circumference of the circle of which the mirror is a segment. This point is called its *focus for parallel rays*, or principal focus.

When the media, through which light passes, are of different densities, *refraction*, or change of course in the direction of the rays, takes place.

A ray of light is compound, and its analysis may be effected either by refraction or absorption.

By refraction, Newton, who first discovered the compound nature of solar light, effected its decomposition. His mode of operation consisted in admitting a ray of light into a dark chamber, through a nearly closed window-shutter, so that it fell obliquely on a glass prism. By this means an oblong coloured surface, composed of seven different tints, is produced. These colours are termed *prismatic*, constituting what is called the spectrum of white light, and are arranged in the following order :—

Fig. 13.



From this and other experiments Newton inferred that white light is a mixture of these seven colours, and that

their separation depended on an original difference in their refrangibility, the violet being the most refrangible, and the red least so.

Bodies which allow of the transmission of light are clear and transparent; those which reflect it unchanged are white; and those which absorb all the rays which fall upon them are black. When a body absorbs some of the rays of light, and reflects the rest, it is always of that colour which is produced by the combination or mixture of those rays which it reflects. When only one kind of ray is reflected, the reflecting substance has the same colour as that ray.

Experiments tend to prove that the seven colours of the spectrum are produced by three primitive or simple rays—namely, the red, yellow, and blue. These rays are concentrated in the spectrum, where the primary ray appears; but each extends more or less over the surface of the spectrum, the mixture of red and yellow giving orange; of yellow and blue, green; and red, with blue and a little yellow, producing the violet.

The maximum of illuminating power lies in the brightest yellow or palest green; the latter is almost equally bright with the yellow; but with the deep green the illuminating power sensibly decreases.

When a delicate thermometer is placed a little beyond the red ray there is evidence of the greatest heat at that spot.

Solar light is capable of producing remarkable chemical changes. Among these the most striking are its bleaching and deoxidizing powers. The latter power is well illustrated in the daguerreotype, in which the oxide of silver is *reduced* by the solar light. This is supposed to be produced by certain rays which have a distinct action, termed *actinism* (from ἀκτίν, a ray). Without solar light, vegetables lose their green colour and active qualities, and become pale, and loaded with a succulent cellular tissue. Gardeners take advantage of this property for bleaching celery, endive, &c. Men and animals also suffer, when deprived of light, in a manner familiar to all.

Polarization of Light.—When a ray of light is allowed to pass through certain crystals, it becomes split or divided into two rays, one of which follows the general law of refraction, and the other takes a different course, according to the position of the crystal. This effect, which is called *double refraction*, is beautifully illustrated

in the case of Iceland spar or crystallized carbonate of lime.

Again, if a ray of light be suffered to fall on a plate of glass at an angle of 56° 44′ the portion of the ray which suffers reflection will be found to have acquired properties which it did not before possess; for on throwing it with the same angle upon a second glass plate, it will be seen that there are two particular positions of the latter in which the ray ceases to be reflected. Light which has suffered this change is said to be *polarized.*

Spectrum Analysis.—When a ray of sunlight is allowed to pass through a prism, it is seen to be broken up into its component parts, and a miniature rainbow is called forth, exhibiting all the shades of light found in Nature's arc. When the prism is so placed that the ray passing through can be exactly seen, either by being received on a white sheet, or by an instrument made for the purpose, and called a *spectroscope*, the component shades of light, if minutely examined, will be found to exhibit dark lines in certain definite places. The same phenomena can be seen when a candle flame or blowpipe flame is looked at, only the lines are no longer dark, but coloured, and coloured differently for different substances. To understand this aright, it is necessary to know that different bodies give in the blowpipe flame different colours. Soda gives an intensely yellow flame, and so plentiful is soda, that any ordinary substance, a piece of wood, a speck of dust, &c., gives a yellow tinge to the flame, obscuring the colour of any other substance that may be present. If, however, a piece of pure potash salt be submitted to the flame, a purple colour characteristic of potash is obtained. Other metals give specific colours, until a long list of substances and the colour they each give to a blowpipe flame could be built up. Now, as it is in the blowpipe flame, so it is in a ray of light. Interpose a sodium salt between the light-giving body, whether it be the sun or the flame of a candle, &c., and characteristic lines will be found to exist on the colours of the decomposed ray. This particular substance, soda, for example, will give only one bright yellow line; on the other hand, the purple flame of a potash salt will give two bright lines, one in the violet rays and the other in the red. These lines are diagnostic of the presence of soda and potash respectively, and of nothing else. Both potash and soda may be present together, and still the

sets of lines will appear in the spectra at the same time; so that a flame of yellow from soda will, if potash be present in the same flame, exhibit the lines characteristic of both. So, in addition to these two, were any others present, they would all in the same flame and on the same spectrum show lines characteristic of each individual element present in the flame, and the lines of no two salts would interfere with each other. Hence it is possible to analyse the substances present in any flame or light by these lines on the coloured prism rays.

The cause of the solar lines being dark, whilst the lines from an ordinary flame are coloured, is accounted for thus: allow the rays from a strong light to pass, first through a flame coloured by soda, and then examine with a spectroscope. It will be found that the lines, characteristic in position with soda lines, are present, but they are no longer coloured. This state of things is actually what happens in sunlight. The white light from the sun passes through the gases of the metals in the sun's atmosphere, and consequently the colours are concentrated, as we saw experimentally, and dark lines appear instead of coloured lines in the solar spectrum. The minute nature of this means of analysis may be understood, when it is said that one-millionth part of a grain of many substances is sufficient to give the lines characteristic of the substance present in the light.

ELECTRICITY.

The most usual forms of electricity met with are:

1. *Static* electricity, called also *frictional* electricity; or from its exponent, Franklin—*Franklinism.*

2. The *continuous* current, called also the *battery* current; or from its discoverer, Galvani—*Galvanism;* or from its exponent, Volta—*Voltaic* electricity.

3. The *interrupted* current, called also the *induced* current; or from its exponent, Faraday—*Faradism.*

I. Static or Frictional Electricity, or Franklinism. —When a glass rod is rubbed with a silk handkerchief it at first attracts, and then repels, bits of paper, or cotton, feathers, or gold leaf. The principle thus brought into action is called electricity, from the Greek word, ἤλεκτρον, amber, because the electric property was first excited in this substance.

The phenomena of electricity are strikingly produced by an *electrical machine*, which consists essentially of a glass cylinder fixed upon an axis, and pressed by a *cushion* or *rubber* which is generally smeared with a soft compound of an amalgam of mercury and tin mixed with grease. At a short distance is placed a metallic cylinder, supported on glass feet, called the *prime conductor*, which, at the end next the glass cylinder, has commonly a few projecting teeth made of pointed wire. The rubber being connected by a small chain, or other means, with the table or floor, and the glass cylinder made to revolve upon its axis, a crackling noise is heard, attended with a luminous appearance, and on bringing the knuckle of a finger, or a metallic knob near the prime conductor, a spark issues, accompanied by a slight report, and, if the knuckle has been applied, with a pricking sensation. In this case the glass is said to be *excited*, and the prime conductor to be *charged* with electricity.

If, while the prime conductor is charged, two gilt pith balls, suspended by fine silken threads, and in contact with each other, are approximated to the conductor, they immediately fly asunder, but on being moved away they again fall together. Now these two balls, under the above circumstances, being in the sphere of the same influence, may be considered as in the same state of electricity; and hence *bodies similarly electrified repel each other.* Instead, however, of connecting the rubber with the floor, connect it with a second prime conductor, and let a wire be attached to each conductor, from which the balls may hang separately, each by its thread, with a small space intervening between them. The balls will now attract each other, and come into apposition. *Bodies, therefore, dissimilarly electrified, attract each other.*

Bodies are said to exist in two states of electricity: those containing a large quantity, or *plus*, of electricity, are said to be *positively electrified;* on the contrary, those which contain a small proportion, or *minus*, of this fluid, are said to be *negatively electrified.* Hence the terms *positive* and *negative* electrics, the former corresponding to the *vitreous* and the latter to the *resinous* electrics.

When it is intended to collect a quantity of electricity, so that a powerful charge may be accumulated, the *Leyden jar* is generally employed. This is a glass jar which is lined internally, and coated externally, to a certain height with tin-foil, and closed at the top by

a cork through the middle of which there passes a brass rod; a brass chain is attached to the end of this rod, which is within the jar, extending down and resting on the metallic lining, while the other end, which is without the jar, terminates in a small ball of the same metal. When this metallic ball is placed in contact with the prime conductor of an excited electrical machine, while the outer coating communicates with the ground, the interior of the jar acquires a charge of positive electricity, and the exterior becomes as strongly negative. In order to *discharge* the Leyden jar, one end of a conducting substance should be applied to the brass ball, and the other end to the external coating of the jar: the moment the communication is established between these two parts, the internal metallic lining gives off its excess of electricity to the external metallic coating, the two fluids rush together with violence, and thus the electric equilibrium is restored.

The phenomena of thunder and lightning depend on electricity, and are produced by the clouds becoming positively electrified, and discharging their electricity upon the earth, or *vice versâ*.

II. The Continuous Current, or Galvanism, or battery current, takes its origin from chemical action. The simplest form of galvanic *cell*, as it is called, is made by immersing two metals, say a plate of zinc and a plate of copper, in water acidulated with sulphuric acid. Connect the two plates by a copper wire, and an electric current will travel along the wire. To prove this, cut the wire, and a spark will be elicited when the two cut ends of the wire are brought close together, or between the cut ends place a galvanometer, and the needle will be found to be moved or deflected. The *zinc* plate is the one acted on by the sulphuric acid, and is called consequently the *generating* plate, whilst the *copper* is the *collecting* plate. The current of electricity travels in the fluid *from the generating to the collecting plate*, and hence along the wire from the copper to the zinc. When the wire is cut, the two ends, or *poles*, as they are called, differ. One, that is the one connected with the copper plate, is called the positive pole, the other, the one connected with the zinc plate, is called the negative. The sulphuric acid becomes sulphate of zinc, and the acidity of the fluid consequently disappears. The hydrogen, generated from the zinc plate, collects on the copper,

and metallic zinc comes in time, to form a coating to the copper plate, and the conduction from both causes is impaired. This is called the polarization of the copper plate. The only use of describing this cell is to simplify the understanding of the galvanic current, as such a battery is of little practical use.

To overcome these drawbacks, many elements have been devised, and many forms of batteries invented.

Daniell's cells consist of a large glass or porcelain vessel containing a saturated solution of sulphate of copper. Into this is placed a strip of perforated copper, bent so as to fit the vessel. Within the copper is placed a cylinder of unglazed porous earthenware, containing a plate of amalgamated zinc, immersed in dilute sulphuric acid. Two strips of copper, attached one to the zinc and one to the copper plate, will serve to connect a series of cells of a like nature together, so as to build up a battery of many cells. The parts of this cell are then, from without inwards, a glass vessel, a copper plate immersed in a solution of sulphate of copper, a porous earthenware cylinder, containing within it a zinc plate, immersed in dilute sulphuric acid.

When the circuit is closed, the hydrogen is liberated from the zinc plate, and collects on the copper, but meets there the sulphate of copper, which it reduces to copper and sulphuric acid. The sulphuric acid thus generated permeates the porous earthenware cylinder, and replaces the acid within. The only thing required to be done to this cell to keep it acting, is to keep the sulphate of copper in excess.

Various modifications of Daniell's cell exist, such as *Grove's*, *Bunsen's*, *Stoehrer's*, and *Smee's*, but the cell that is at present best adapted for medical purposes, is the *Leclanché*.

Grove's element consists of a glass vessel containing dilute sulphuric acid, in which is placed a cylinder of zinc. Within the zinc is a porous earthenware vessel containing strong nitric acid, and in the nitric acid is suspended a plate of platinum. The hydrogen generated from the zinc finds its way through the porous vessel, and instead of polarizing the zinc, reduces the nitric acid.

Bunsen's battery, or the zinc-carbon battery, is simply the using a rod of gas carbon instead of the platinum. The nitrous fumes given off from both Bunsen and Grove's batteries, render them objectionable.

Leclanché's elements consist of small triangular vessels with a porous diaphragm dividing the vessel into two compartments. In one compartment is a rod of carbon, packed with a mixture of peroxide of manganese and coke; and in the other is a mixture of chloride of ammonium and water, into which a rod of zinc dips. The exciting liquid is the chloride of ammonium; chloride of zinc is formed, and hydrogen and ammonia set free. The free ammonia dissolves in the water, whilst the free hydrogen passes through the diaphragm, and reduces the peroxide of manganese, setting up a current thereby.

A number of elements, arranged in such a method, that the generating plate of one element is in connection with the collecting plate of its neighbour, constitutes a *battery*. These elements can be increased to any number.

At either end of the battery are the wires, or poles, charged, one with positive, the other with negative, electricity. When these are brought together, or when any conducting substance, or conductor, is placed between them the circuit is *complete* or *closed*. When the ends are apart the circuit is said to be *open*. If any substance is placed between the ends, through which the current cannot pass, it is said to be a *non-conductor*.

All substances offer a resistance to the passage of electricity, some more, some less. Those through which it can pass easily—*i.e.*, without much resistance—are called *conductors;* they are—metals, carbon, acidulated liquids, and the bodies of animals. Those through which it passes with great *difficulty*, or it may be not at all—*i.e.*, offer much resistance—are, resins, gutta percha, and porcelain. To prevent the escape of electricity from a metal conductor, it is surrounded by a non-conductor, such as gutta percha, and the metal is said to be *insulated*.

By *electro-motive* force is meant the electric power of any given cell or battery.

By *intensity* is meant, the amount of electricity which in a given time flows through any given part of the circuit.

The *quantity* of electricity refers to the size of the plates employed.

By *tension* is meant the the tendency of electricity accumulated at the poles of a battery to free itself.

By *density* is meant the proportion of electricity to the sectional area of the conductor. A wire varying in size has different density in its thick and thin parts.

LAWS OF ELECTRICITY.

Ohm's Law.—1. *The intensity of the current is equal to the electro-motive force divided by the resistance:—*

C = current. E = the power. R = resistance.

$$C = \frac{E}{R}.$$

The resistance of a conductor depends on *three* things:—*a*, its conductivity; *b*, its section; *c*, its length.

2. *The resistance is inversely as the section, and directly as the length of a conductor.*

III. Induced Electricity.—The *interrupted* current, or *Faradism.* Induction currents are either *voltaic,—i.e.,* generated from an ordinary battery—or *magnetic. By induction is meant the power that a conductor has of causing an electric action upon any conductor in close proximity with it.* Round a piece of wood coil a copper wire, and over it place a second coil of the same wire (the wire is insulated—*i.e.,* enclosed in gutta percha or silk). Now, through one of the coils, say the inner, pass an electric current from a galvanic battery. The current sent through the inner coil will induce in the superimposed wire a distinct current, differing in character and action. *This induced current finds expression only when the circuit is broken or closed.* Hence it is necessary to arrange the parts of an induction apparatus so as to get contact broken and closed rapidly. To understand the method aright, examine any induction battery in ordinary use. First, there is a galvanic battery, as described above; secondly, there is alongside of the battery an induction apparatus, consisting of coils of insulated wire. These coils are placed one within the other. The inner coil consists of copper wire coiled round a thick rod of soft iron wire, which projects at either end of the copper wire. Around this is a brass tube, capable of being pulled up and down; and, outside the brass tubing, a second coil of fine copper wire, and having many more turns than the inner. The inner coil is alone in connection with the galvanic battery. On the top of the thick rod of iron, in the inner coil, is a small hammer, by the attractions and repellings of which contact is broken and closed—*i.e., interruption* is provided; and it is this action which causes the noise when an induction coil is in action. The cause of the hammer movement is the magnetic condition into

which the rod of iron wire is thrown. When an electric current flows through the wire surrounding it, the iron becoming magnetic, attracts the hammer, which becomes thereby charged with magnetism, and then, as magnetic bodies do, the two repel each other, only again to be attracted and again repelled. This hammer is in the circuit, and its contact with the iron is necessary to complete the circuit, hence by the hammer movement interruption is provided for.

The *strength* of the current can be regulated by raising the metallic element of the galvanic cell partially out of the trough of acid.

The *amount* of induction employed is regulated by the changing the position of the brass tube separating the inner or primary from the outer or secondary coil. In all batteries used for medical purposes, means are provided whereby either the primary or the secondary coil can be used at will without changing the connections of the conductors. A *key* and *commutator* and a *rheotome* is also provided, enabling the circuit to be closed and broken without moving the conductors.

WATER. H_2O. 18.

Water is used for cooking, drinking, washing, cleaning streets, flushing sewers, public baths, and as a solvent and vehicle in many medicines.

The *sources* of water are either the air and clouds, from which it falls in the form of dew and rain, or, the earth, which renders it up in the form of springs, wells, rivers, or lakes. Rain-water, dew, or that derived from melted snow or ice, is absolutely pure when obtained in country places, but, when near towns, may contain carbon, carbonic acid, &c. Water obtained from wells, rivers, &c., will contain whatever soluble salt or organic matter it happens to come in contact with. Hence it is evident there must necessarily be an infinite variety of waters according as it traverses a pure or foul atmosphere, or a soil that contains salts or organic material that can be dissolved or held in suspension. We hear, for instance, of *soft* and *hard* waters, and of waters used for *medicinal* purposes according as they contain this or the other salt, which renders the solution purgative, tonic, astringent, alterative, &c.

Rain water is *soft* water, and is useful for household purposes, but not agreeable to drink.

Hardness in water depends on the presence of mineral salts, such as calcium, magnesium, and iron. This property renders a lather with soap difficult, and necessitates the waste of much soap. The fatty acids in the soap form insoluble compounds of calcium, magnesium, and iron, and, until this is done, no lather is formed.

Water containing much carbonic acid can dissolve up chalk very readily; but this hardness can be got rid of by boiling, when the carbonic acid is driven off, and the chalk is precipitated. This constitutes *temporary hardness.*

Very hard water can be softened by adding milk of lime to the water, when the lime combines with the free carbonic acid gas, and falls. The water deprived of this solvent agent will be still farther freed of the chalk that depended for its presence in solution upon the free carbonic acid. Gypsum, or sulphate of lime, on the other hand, is but little affected by boiling, and constitutes *permanent hardness* of water. Filtration through charcoal filters, as is usually done on a small scale in houses, or through sand, as is done on a large scale in filtering water supplied to towns, removes the sand and mud suspended in water, and renders the water clear.

To obtain water perfectly pure it requires to be distilled. Distilled water, however, is not pleasant to drink, and for purposes of digestion is derogatory. The boiling of water is a sufficiently good purifying process, removing much of the hardness from chalk, and destroying the vegetable or animal life that may be present. Boiled water, to be pleasant to drink, must be mixed with air. This is generally done by pouring water from a height from one vessel to another.

The *medicinal* waters can be classified under the following heads:—

I. Chalybeate or Ferruginous Waters.

Carbonate of soda, held in solution by carbonic acid, is found in the wells of Spa, Tunbridge Wells and Harrogate.

Sulphate of iron exists in the wells of Sand Rock, Isle of Wight, Brighton, &c.

The waters are used in cases of anæmia, for which purpose the carbonate of iron is to be preferred.

II. Acidulous or Carbonated Waters.

Carbonic acid is the main source of their usefulness; the water either being used from the fact of the presence of the gas itself, or from the salts which may happen to be held in solution by it; these are, the carbonates of lime, magnesia, and soda.

The most celebrated waters are those of Carlsbad, Geltzer, Ilkeston, Apollinaris, &c. These waters are used in dyspepsia, kidney and skin diseases, gout, rheumatism, &c.

III. Saline Waters.

1st. *Purgative.*—Contain sulphates of soda and magnesia, and are found in Cheltenham, Leamington, Purton, Seidlitz, Püllna, and Friedrichshall waters. Used in portal congestion.

2nd. *Calcareous.*—Contain carbonate and sulphate of lime as their chief ingredients, and are found in this country at Bristol, Buxton, and Bath. Used in gout, rheumatism, and skin affections.

3rd. *Salt.*—Contain chiefly chlorides, with, in some places, iodine and bromine. They are found, for the most part, at Wiesbaden, Baden-Baden, and Kreutznach.

4th. *Alkaline.*—Contain alkaline carbonates, as those of Vichy and Ems. Used by gouty people, and by those suffering from uric-acid diathesis.

IV. Sulphuretted or Hepatic Waters,

all contain sulphuretted hydrogen, and are found in the waters of Harrogate, Moffat, Cheltenham, Strathpeffer in Ross-shire, Aix-la-Chapelle, Borcet, and Aix. Used in skin and uterine affections, and in rheumatism.

Physical Properties of Water.

Water exists as a solid, as a liquid, and as a gas. The zero of the Centigrade and Reaumur scales, and 32° of the Fahrenheit, are determined by the melting-point of ice. When the temperature of water rises or falls, a circulation is set up, and the whole of the water becomes reduced or raised in temperature. Whilst the temperature of the water is falling, the hotter water rises to the top, and coming in contact with the cold air becomes reduced in temperature and sinks. The cooling progresses, until the top layer gets reduced to 0° C., or 32° F., and a thin layer of ice is formed. That the whole mass of any bed

of water is not converted into ice is dependent on the fact that the water below the forming ice is never reduced to 0° C., or 32° F., but retains the temperature of 4° C., or 39° F. Thence is deduced the rule, *that water above or below 4° C. is lighter than water at 4°; or that the point of maximum density of water is 4° C.*

Water, when heated to the boiling-point, passes into the gaseous state, *steam*. This is represented in the different scales thus: F. 212°, C. 100°, R. 80°. By the *boiling-*point of water is meant *that point at which the tension of its vapour is equal to and then overcomes the superincumbent pressure of the air.* Hence, the lighter the air the sooner the water will boil; on ascending a high mountain, water will boil with so little heat, that potatoes cannot be properly cooked.

Latent Heat.—Ice melts when the temperature of the air around it is higher than 0° C. A peculiar phenomenon is observed in the melting. The water, as it trickles from a melting block of ice, say in a basin, remains just above 0°, until the last particle of ice is melted. Again, if a quantity of water is poured over a block of ice, the ice melts, and the temperature of the water is reduced gradually until 0° C. may be reached. What has become of the heat in these instances? It has become "*latent.*" By experiment, the latent heat of water is found to be 79° C. thermal units. By a "thermal unit" is meant the amount of heat required to raise a unit weight of water through 1° C.

Whilst passing from the liquid state to the gaseous, heat also becomes latent. *By experiment the latent heat of steam is found to be 536 thermal units.*

The decomposition of water into its elementary gases, hydrogen and oxygen, constitutes its *analysis*, and the forming water, by bringing together hydrogen and oxygen in proper proportions, constitutes its *synthesis*.

To *decompose* water, invert two glass tubes filled with water over two poles of a battery immersed in water. Acidulate the water slightly with H_2SO_4, to conduct the electricity better. Now connect the battery with the conductors. The inverted vessels will be gradually filled with gases. The vessel over the negative pole will get gas generated twice as fast as that over the positive. When the invertedvessels or tubes are nearly full test for the presence of oxygen and hydrogen. It will be found that the bulk of the oxygen is over the negative, whilst the

Hydrogen is over the positive pole; hence one reason for the formula H_2O.

The two gases can also be *brought together* in the following way, constituting the *synthesis* of water. This is best done by the *eudiometer*. This is a strong carefully graduated glass tube. Through the closed end of the tube two platinum wires are introduced. The tube is now filled with mercury, and inverted in a trough of mercury. Hydrogen is now conducted by a glass tube from the bottle in which it is manufactured, in the usual way, and allowed to pass up the tube. Oxygen is also introduced in the same way; the proportions being $\frac{1}{3}$ oxygen and $\frac{2}{3}$ hydrogen, and this is accurately gauged by the lines on the tube. The platinum wires are now connected with the poles of a battery, and a union of the oxygen and hydrogen takes place with some amount of disturbance and expansion. Steam is now seen to form in the tube, and the mercury rushes up, practically filling the whole tube. It is found then that 100 volumes of hydrogen require 50 volumes of oxygen, hence another reason for the formula H_2O.

CARBON. C. 12.

Sources.—Wood and bones are the chief sources, but carbon is also found as the diamond in various parts of the world, and graphite or plumbago in Cumberland, Ceylon, &c. When animal or vegetable substances are heated in a vessel nearly closed, a quantity of volatile matter distills over, and charcoal—*i.e.*, carbon—is left. The porous character of charcoal enables it to absorb largely such matter as ammonia, oxygen, &c., and it is largely used in refining sugar, filtering water, and as a disinfectant. The air absorbed in the charcoal before use likely accounts for its action.

Coal comes to be discussed under carbon, of which it is an important variety. *Coal is woody fibre that has become bituminised and retained much of its oxygen and hydrogen.* There are many different kinds of coal, the types, however, are anthracite and bituminous coal. The anthracite or stone coal differs from the ordinary or bituminous coal, in containing less volatile matters, in burning without flame, in giving a higher temperature, and in caking less when burnt. When coal is burnt, as in an ordinary fire, the carbon of the coal unites with the

oxygen of the air, forming CO_2, carbonic dioxide. This gas, when it passes over the red-hot embers becomes decomposed, and forms CO, carbonic monoxide and oxygen. The carbonic monoxide set free, burns with a bluish flame, unites with oxygen at the top of the fire, and again forms CO_2, which being heated ascends and escapes partly at the top of the chimney, and is partly absorbed by the soot on the way up. Much the same process takes place when a candle or some such body is burning. The *flame* consists of three zones; the central or *gaseous* zone is seen to be of a bluish colour. It is caused by the heat of the flame melting the wax in the immediate neighbourhood, and causing it to be soaked up and rendered gaseous. Next is the *luminous* zone, or zone of incomplete combustion, where the carbon particles in a solid state become red and reflect light. In the *outer* zone, the supply of oxygen is sufficient to allow of complete combustion, and carbonic dioxide, CO_2, is formed, and the flame becomes non-luminous. In a *Bunsen's* burner, the air is allowed to mix with the flame at the bottom of a long metallic tube, and the flame issues at the top, as a non-luminous perfectly smokeless flame; on closing the holes the ordinary luminous smoky flame is obtained.

In the *blowpipe flame* we find an inner or *reducing* flame and an outer or *oxidizing* flame. The inner portion of the flame consists of the gases of the hydrocarbons, heated to a temperature at which they readily combine with oxygen. When therefore any metal combined with oxygen is presented to this portion of the flame the two are speedily parted, and the pure metal obtained. The outer portion of the flame contains excess of oxygen, hence it is called the oxidizing flame.

Gases require a certain heat before ignition occurs. A flame can even be *cooled down* to such an extent that it goes out; and this fact of cooling flame is made practical use of in many ways. Over a Bunsen's burner, place a wire gauze containing about 700 meshes to a square inch; now apply a light to the upper surface of the wire gauze, and the gas issuing through it from the bottom, is ignited. The flame does not, however, pass down through the gauze, as its heat is conducted away so rapidly that the temperature of the gas below the gauze cannot be raised to the point of ignition. *Sir Humphry Davy's miner's lamp* was devised on this principle. This consists of an oil lamp enclosed

in wire gauze. Gases can pass inwards and outwards, but no flame can pass through the gauze in ordinary conditions, owing to the reduction of temperature the flame undergoes at the gauze.

In connection with the subject of coal we have many subjects to consider.

I. CH_4. *Light Carburetted Hydrogen.*—This is found in coal mines, and is known as *fire damp*, from its tendency to unite with oxygen of the air, whereby an explosion occurs. The result of this union is the production of $H_2O + CO_2$; the latter in this instance goes by the name of *choke damp.* CH_4 also goes by the name of *marsh gas*, from the fact that it occurs in marshy districts, or where vegetable matter is decaying.

II. C_2H_4. *Heavy Carburetted Hydrogen. Olefiant Gas.*—This is one of the many important constituents of coal gas. It burns with a luminous smoky flame, forming carbonic dioxide and water. From the fact that this gas unites readily with its own volume of chlorine gas, forming an oily liquid, it has received the name of olefiant gas.

From coal gas are derived many articles used in medicine and the arts. In order *to prepare coal gas*, coal is heated in a closed retort. The coal is broken up, and *volatile bodies—i.e.*, the gas—are distilled over; the residue left in the retort is *coke.*

a. Of the *volatile products* ammonia is one; it is collected by passing the coal gas through water. To this ammonical liquor, hydrochloric acid is added, and chloride of ammonium, the source of most of the ammoniacal compounds, is obtained.

b. Of the *illuminating substance*, olefiant gas, C_2H_4, and various other hydrocarbons are the most important. Besides these, hydrogen, carbonic oxide, and marsh gas are generated, and as each is inflammable it adds to the illuminating power of the gas.

c. *Tar* is another product of distillation from which many useful substances are obtained. Of these, *carbolic acid* and *creasote* are used medicinally. *d.* Colouring matters, chief amongst which is *aniline*, are also obtained from gas tar. Aniline may be found free in the tar, but it chiefly exists there as *benzol*, C_6H_6, from which it can be obtained by adding nitric acid, nitro-benzol is produced, and this in contact with H_2 or other reducing agent forms *aniline.* By oxidation, aniline forms *mauve*,

and in addition we get aniline-red, yellow, green, blue, and all the aniline dyes, lakes and pigments used by the dyer and colour printer, in use in calico printing, and in woollen and silk dyeing. Mordants, *see* Alum.

SULPHUR. S. 32.

Source.—Sulphur is found in a free state in the neighbourhood of volcanoes, and in a state of combination with many metals. It is found in Nature in the form of sulphides, sulphates, sulphurets, &c. Of the sulphides the most important are: Galena, PbS; blende, ZnS; and copper sulphide, CuS. Of the sulphates, the most important are gypsum, $CaSO_4$; heavy spar, $BaSO_4$; Glauber salt, Na_2SO_4. As sulphurets, it occurs as H_2S in the water of certain places, as Harrogate and Strathpeffer.

Sulphur is separated from the ores containing it by heating in earthenware pots. The sulphur distils over as vapour, is collected, and again distilled until it is found to be pure. *Flowers* of sulphur is the name given to the products of the distillation. *Roll* sulphur, or brimstone, is the name given to the sticks of sulphur; they are obtained by gently heating the flowers, and casting the melted sulphur into moulds.

Properties.—Sulphur burns with a bluish flame, gives off a characteristic odour, and forms SO_2. Insoluble in most fluids, it is dissolved readily by carbonic disulphide, CS_2. It exists in three different forms. 1. As crystals found in Nature, rhombic octahedra. 2. As long, needle-shaped crystals, prismatic in outline, obtained by slowly cooling melted sulphur. 3. As an allotropic condition. When sulphur is raised to a temperature of 230° F., and poured into cold water, it forms in the water a soft pliable mass, capable of being pulled out, and receiving the impression of the fingers. This state, to which the name allotropic is given, is not permanent. When sulphur is heated it passes through various phases. At 115° it begins to melt, and is amber in colour; at 230° it becomes thick and treacly, and is dark in colour; at 250° it becomes thin, and is of a reddish black colour; at 490° it begins to boil, and gives off red fumes; at 600° it sublimes and forms:

I. Sulphur sublimatum, flowers of sulphur.

Properties.—A fine greenish yellow gritty powder.

D. As a stimulant, 10 grs., as a laxative, 60 grs.

Preparations :

a. Confectio sulphuris. *D.* 120 grs. Sulphur, 4; acid tartrate of potash, 1; syrup of orange peel, 4.

b. Unguentum sulphuris. (1 in 5.)

From hence :—

(i.) Sulphur præcipitatum. *D.* Same as sublimed.

Used externally to destroy the acarus scabiei; internally as a stimulant in small, and as laxative in larger doses, in constipation, piles, and skin diseases.

The further details of sulphur are noticed in connexion with sulphuric acid, sulphurous acid, iodide of sulphur, sulphide of calcium, &c.

CHLORINE. Cl. 35·5.

Source.—Common salt, by heating with sulphuric acid and dioxide of manganese.

$$2NaCl + 2H_2,SO_4 + MnO_2 = 2Cl + Na_2,SO_4 + MnSO_4, + 2H_2O.$$

Properties.—Chlorine is a yellow or greenish-yellow gas, with a disagreeable odour. It is freely soluble in water, and if metals finely powdered are brought into contact with chlorine, they take fire spontaneously.

Chlorine and hydrogen readily combine, and it the two gases are nearly equal in volume, they combine with a detonation. The property of *bleaching* possessed by chlorine is due to its affinity for hydrogen; chlorine seizing the hydrogen of water and setting the oxygen free. The oxygen freed is in a *nascent* state as it is called, and, combining with vegetable colouring matter, bleaches any material with which it comes in contact. There are many oxides of chlorine.

$$Cl_2O, Cl_2O_3, Cl_2O_4, Cl_2O_5, \text{ and } Cl_2O_7.$$

The three first exist and form combinations. The last two have not been prepared, but they form the bases of various salts; and it is from the composition of these salts that their existence is inferred.

Salts of Chlorine are mentioned elsewhere. *See* Chlorinated Lime and Soda.

Preparations ;

a. Liquor chlori. *D.* 10-30 mins. Passing chlorine gas into cold water. Used in throat and mouth diseases. *D.* 10-30 mins.

b. Vapor chlori. Moisten 2 oz. of chlorinated lime with cold water, and inhale the vapour in mouth and throat diseases.

IODUM. I. 127.

Source.—Sea-weed. The *fuci* and *laminaria* sea-weed, washed up on the shores of the west coast of Ireland, and the north and west of Scotland, are collected, sun dried, and then burnt. This constitutes *kelp*, which is reduced to powder, and dissolved in boiling water. A large proportion of the kelp is dissolved, and the partial evaporation of the solution in open vessels is proceeded with. During the evaporation the carbonates and sulphates of soda, sulphate of potash, and potassium chloride crystallize out. When this has happened, the evaporation is stopped, and to the liquid, now called *iodine ley* or *mother liquor*, sulphuric acid is added. The whole is now allowed to stand for twenty-four hours, during which time gases, such as carbonic acid and sulphuretted hydrogen, are given off; and sulphur and sulphate of soda are deposited in the vessel. The supernatant fluid is then poured into a leaden retort, manganese dioxide is added, and the temperature of 140° is maintained. Iodine vapour slowly rises, and is received in glass condensers, where it solidifies into dark violet looking scales.

The chemical formulæ representing the changes are as follows :—

$$2NaI + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnSO_4 + 2H_2O + I_2.$$

i.e., iodide of soda + dioxide of manganese + sulphuric acid = sulphate of soda + sulphate of manganese + water + iodine.

Properties.—Iodine is found as deep violet crystalline scales, possessing a metallic lustre. It is readily dissolved in a solution containing iodide of potassium, hence iodide of potassium is contained largely in preparations.

Preparations :

I. Iodine. *D.* ½–1 gr.

a. Linimentum iodi (1 in 9). Iodine, iodide of potassium, spirit and camphor.

b. Liquor iodi (1 in 29). Iodine, iodide of potassium, and water.

c. Tinctura iodi. *D.* 5–20 mins. (1 in 40.) Iodine, iodide of potassium and spirit.

d. Vapor iodi. Water, 1 oz.; tincture of iodine, 1 oz.
e. Unguentum iodi (1 in 31). Iodine, iodide of potassium, proof spirit, and lard.

II. Sulphuris iodidum. S_2I. *D.* 2 grs. Made by heating iodine and sulphur together. It occurs as greyish-black lumps, with a crystalline appearance.
a. Unguentum sulphuris iodidi, (1 in 19).

Used internally as an alterative, and externally as an irritant and vesicant in scrofula, syphilis, gout, rheumatism, skin-diseases, and glandular enlargements.

Preparations, noticed elsewhere, Iodide of Potassium, Iodoform, Iodide of Lead, Iodide of Iron.

BROMINE. Br. 80.

Source, sea-water. After common salt is crystallized out of sea-water, the mother liquor that remains contains, amongst other salts, bromine in combination with soda and magnesia. Through the fluid, chlorine gas is passed; this seizes on the soda and magnesia, and sets the bromine free. Sulphuric ether is now added, which dissolving up the bromine, rises to the surface, and is poured off. To the ethereal solution thus obtained, caustic potash is added, whereby the bromide and bromate of potash are formed. The ether is now evaporated off, and the salts exposed to red heat, whereby $KBrO_3$, the bromate, is converted into KBr, the bromide. To the bromide, sulphuric acid, dioxide of manganese, and water are added, and distilled together, when a vapour passes over, which finally becomes condensed into bromine.

Reactions are as follows:—

$$2H_2SO_4+2KBr+MnO_2=K_2SO_4+MnSO_4+2H_2O+Br_2.$$

Properties.—A dark brown liquid, giving a disagreeable stench, whence its name. The vapours given off when it is heated are orange-red in colour.

Used but little in medicine. Its preparations are discussed elsewhere, under Bromide of Potassium and Ammonium.

ACIDS.

Under this heading will be discussed the mineral and a few of the vegetable acids; the remainder of the latter will be found under the various substances to which they belong.

I. Acidum Sulphuricum. H_2SO_4.

Source.—The constituents necessary to form the acid—viz., O_2, SO_2, and H_2O, are brought together in a large leaden chamber. The sulphur dioxide, SO_2, is procured by burning sulphur, or pyrites, FeS_2, in a furnace, the fumes from which are conducted by a pipe or flue into the leaden chamber. The oxygen necessary cannot be obtained from the air directly, but the following agencies are employed:—In a small stove behind the sulphur furnace, sodium nitrate, $NaNO_3$, is placed, with sulphuric acid, H_2SO_4, added. (In commerce, $NaNO_3$ is used, but in the laboratory, KNO_3.) Fumes of nitric and nitric peroxide, N_2O_4, arise and pass into the chamber, supplying the necessary oxygen; for explanation, *see* Equation. Jets of steam are blown into the chamber at various points, and a high chimney allows for a draught to cause all components to meet readily.

Equation representing the steps as they occur:—

1. $S_2+2O_2=2SO_2$.
2. $2NaNO_3+H_2SO_4=Na_2SO_4+2HNO_3$.

The fumes of the sulphurous acid gas now meet with steam in the chamber, and uniting, form

3. $SO_2+H_2O = H_2SO_3$.

The fumes rising from the nitre chamber are the reddish-brown fumes of nitric peroxide, N_2O_4. These meeting with H_2SO_3 form

4. $N_2O_4+H_2SO_3 = H_2SO_4+N_2O_2$.

The N_2O_2 (nitric oxide) again picks up O_2 from the air, which is also circulated through the chamber, becoming N_2O_4, and is again circulated through the chamber supplying oxygen.

Properties.—When pure, sulphuric acid is a clear, oily liquid, very heavy, intensely strong, and unites with water, evolving heat.

Preparations:

a. Acidum sulphuricum dilutum. *D.* 5–20 mins.

b. Acidum sulphuricum aromaticum. *D.* 5–20 min.

Used, when strong, as a caustic; when diluted, it is given as a tonic and astringent in internal hæmorrhages, and diarrhœa.

II. Nordhausen Acid.

When ferrous sulphate was used in the preparation of sulphuric acid, fumes were formed consisting of $H_2SO_4+SO_3=H_2S_2O_7$, termed Nordhausen sulphuric acid.

III. Acidum Sulphurosum. H_2SO_3. *D.* ½–1 dr.

Source.—Burning sulphur, or reducing sulphuric acid with charcoal, when the fumes, SO_2 are passed through water, and form $H_2O+SO_2=H_2SO_3$.

Used to destroy the vegetable parasites of the skin.

IV. Acidum Nitricum. HNO_3.

Source.—By decomposing nitre with sulphuric acid :—

$$KNO_3+H_2SO_4=HNO_3+KHSO_4.$$

Properties.—When pure, it is colourless, but usually slightly yellow from the presence of some of the lower oxides. It is strongly fuming, the fumes consisting of N_2O_4, or nitric peroxide for the most part. It does not possess a constant boiling-point, as the acid gradually undergoes change and becomes weaker.

Preparations :

a. Acidum nitricum dilutum. *D.* 10–30 mins.

b. Acidum nitro-hydrochloricum dilutum. *D.* 10–30 mins.

Used, when strong, as a caustic; when diluted, as a tonic.

V. Acidum Hydrochloricum. HCl.

Source.—By decomposing common salt with sulphuric acid :—

$$NaCl+H_2SO_4=HCl+NaHSO_4.$$

This acid is obtained in enormous quantities in the preparation of sodium carbonate (which *see*).

Properties.—A colourless, fuming liquid, having white fumes with a pungent odour.

Preparation :

a. Acidum hydrochloricum dilutum. *D.* 10–30 mins.

Used, when strong, as a caustic; when diluted, as a tonic in dyspepsia.

VI. Acidum Phosphoricum. H_3PO_4.

Source.—Phosphorus, by adding nitric acid and water :—

$$P_6+10HNO_3+4H_2O=6H_3PO_4+5N_2O_2,$$

with the escape of nitric oxide fumes. Or it may be obtained by burning phosphorus in the air, when P_2O_5,

Phosphorus peroxide is first formed, and then uniting with water forms H_3PO_4.

Properties.—Colourless and liquid.

Preparation :

a. Acidum phosphoricum dilutum. *D.* 10–30 mins.

Used as a refrigerant tonic and astringent in hæmoptysis, sweating, and thirst.

VII. Acidum Aceticum. $C_2H_4O_2$.

Source.—The wood of hard wood trees—oak, birch, &c. —is placed in iron retorts, and submitted to heat. Gas and steam rise from the retort, and pass over into a receiver. The gaseous part is allowed to ascend, but the liquid part is allowed to stand and cool. In this liquid is acetic acid in an impure state. To purify this, lime is added, when acetate of lime is formed. The acetate is carefully purified with soda, and then treated with sulphuric acid, when acetic acid and sulphate of soda are formed :—

$$NaC_2H_3O_2+H_2SO_4=C_2H_4O_2+NaHSO_4.$$

Properties.—A colourless liquid, with odour of vinegar.

Preparations :

a. Acidum aceticum dilutum. 1 in 8. *D.* 1–2 drs.

b. Oxymel. 1 in 10. *D.* 1–2 drs.

Used as an astringent in sweating and irritation of the skin.

VIII. Acidum Aceticum Glaciale. $C_2H_4O_2$.

Prepared by distilling fused acetate of soda with sulphuric acid.

Properties.—This acid crystallizes when cooled to 34°, and remains crystalline until the temperature rises to 48°. The sp. gr. is increased by adding 10 per cent of water.

Used as a caustic to destroy parasites, warts, &c.

IX. Acetum (*Vinegar*).

Source.—Vinegar is obtained in this country by the acetous fermentation of malted or unmalted grain. In wine-growing countries the wine juice of inferior quality is allowed to ferment beyond the alcoholic stage, when we have the red and white vinegars, alcohol and oxygen forming acetic acid and water :—

$$C_2H_6O+O_2=C_2H_4O_2+H_2O.$$

X. Acidum Oxalicum. $H_2C_2O_4,2H_2O$. *D.* $\frac{1}{2}$–2 grs.

Oxalates are found in such plants as rhubarb, the wood-sorrel, the common dock, &c., but oxalic acid is preferred artificially.

Source.—Sawdust is roasted with caustic potash—potassium oxalate is thus formed. Lime is now added, and oxalate of calcium results; this, when digested with sulphuric acid, forms oxalic acid, which, to render it pure, ought to be re-crystallized. Oxalic acid is also formed when nitric acid is boiled with sugar.

Properties.— Four-sided prism crystals, which effervesce.—Soluble in water and alcohol, and sublimes without residue at a heat of 320° F. It has an intensely sour taste.

Used as a refrigerant—5 grs. in half a pint of water, sweetened; given once in twenty-four hours. Also used as a sedative and antiphlogistic.

XI. Acidum Hydrocyanicum Dilutum. HCy or HCN. *D.* 2–8 min.

Strength.—2 per cent. of pure acid; Scheele's, 4 per cent.

Source.—Ferrocyanide of potassium, by heating and distilling with sulphuric acid:—

$$2K_4FeCy_6 + 6H_2SO_4 = Fe_2K_2Cy_6 + 6KHSO_4 + 6HCy.$$

This acid is found in a few plants, especially almonds, and is called the volatile oil of bitter almonds, or prussic acid.

Properties.—A clear, limpid fluid, with a peculiar irritating odour.

Preparation:

a. Vapor acidi hydrocyanici. This inhalation is used in chest disease. 10 mins. of the acid to 1 oz. cold water.

Used as a sedative in vomiting, and to allay cough.

XII. Acidum Tartaricum. $C_4H_6O_6$. *D.* 1–30 grs.

Source.—Acid tartrate of potash; the deposit found in wine casks. Boil the acid tartrate of potash (cream of tartar) in water, and add chalk, and then chloride of lime. Effervescence occurs, and a precipitate falls, of tartrate of calcium, which, when washed and treated with sulphuric acid, yields sulphate of calcium and tartaric acid:—

$$2CaC_4H_4O_6 + 2H_2SO_4 = 2CaSO_4 + 2C_4H_6O_6.$$

Properties.—Colourless crystals, with a strongly acid taste, and readily soluble in water.

Used as a refrigerant.

XIII. Acidum Carbolicum. C_6H_6O. *D.* 1–3 grs.

The hydrate of phenyl or phenic acid.

Source.—Coal tar, from which it is obtained by fractional distillation and purification.

Properties.—Colourless crystals, with a strong taste and odour. *a.* Glycerinum acidi carbolici.

Used as an antiseptic and disinfectant. Internally it is given as a sedative in vomiting.

XIV. Acidum Citricum. $C_6H_8O_7$. *D.* 1–30 grs.

Source.—Lemon juice. Add to the juice of the lemon, lime—CaH_2O_2, forming thereby a citrate of lime; to this add sulphuric acid, and citric acid is obtained.

Properties.—Colourless crystals; soluble in water.

Used as a refrigerant.

XV. Acidum Boracicum. H_3BO_3.

Source.—Borax. When hydrochloric acid is added to biborate of soda, boracic acid is formed.

Properties.—White scaly crystals, soluble in hot water and alcohol. The crystals, when touched and worked between the fingers, have an unctuous feel, and are fused into beads in the blowpipe flame.

Used for antiseptic purposes in the form of a lotion, an ointment (1 in 4), and a dry dressing of boracic lint.

SODIUM. Na. 23.

The *source* of most of the sodium compounds is chloride of sodium, obtained native, or from sea water. From chloride of sodium is obtained carbonate of sodium, by a process described below. On heating the carbonate of sodium with carbon, the metal sodium is obtained. Sodium is a silver-white metal, which, when thrown in water, sets free the hydrogen, which is not, however, ignited except under special circumstances. Compounds of sodium are universal in their presence, and yield in all cases a characteristic yellow blowpipe flame.

I. Sodæ Carbonas. Na_2CO_3. *D.* 10–60 grs.

Source.—Chloride of sodium, in the form of rock salt, or as obtained by the evaporation of sea water. In the manufacture of this salt there are two stages:

1st. The salt-cake process, consists in exposing common salt to sulphuric acid in a reverberatory furnace, when sulphate of sodium and hydrochloric acid are formed:

$$H_2SO_4+2NaCl=Na_2SO_4+2HCl.$$

2nd. Soda ash; or, black ash process. Salt cake, Na_2SO_4, is heated, with carbon and limestone, when the following reactions take place:

$$Na_2SO_4+C_4=Na_2S+4CO.$$

The sulphide is now treated with limestone:

$$Na_2S+CaCO_3=Na_2CO_3+CaS.$$

The salts are now separated by dissolving out the sodium carbonate in water, and by subsequent evaporation the sodium carbonate of commerce is obtained.

Properties.—It occurs in colourless, laminar crystals; efflorescent.

Used in dyspepsia as an antacid.

Preparation.—(*a.*) Sodium carbonate exsiccata. Prepared by drying carbonate of soda.

Used, externally as a caustic.

From sodium carbonate is obtained:

1. Liquor sodæ. NaHO. *D.* 10–60 mins. Made by acting on carbonate of sodium with lime water.

   $$Na_2CO_3+CaH_2O_2=2NaHO+CaCO_3.$$

   Used as a caustic and antacid in dyspepsia and lithic-acid diathesis.

From liquor sodæ is obtained:

1. Sodæ caustica. Made by evaporating the liquor sodæ.
   Properties.—Hard greyish-white fragments, very alkaline and corrosive; slightly deliquescent.
   Used as a caustic to destroy fungoid growths.
2. Sodæ bicarbonas, $NaCO_3$. *D.* 10–60 grs. Made by passing a stream of carbonic acid gas through a solution of the carbonate.

   $$Na_2CO_3+H_2O+CO_2=2NaHCO_3.$$

   Properties.—White, opaque, irregular scales.
   Preparations:
   a. Liquor sodæ effervescens.
   b. Trochisci sodæ bicarbonatis, 5 grs. in each. *D.* 1–6.
   Used as an antacid in dyspepsia and lithiasis.

From the bicarbonate are obtained:

(i.) Sodæ citro-tartras effervescens. *D.* 60 grs. to $\frac{1}{4}$ oz. Made by heating the bicarbonate of soda with citric and tartaric acids.

Properties.—Granular powder, deliquescent.

Used as a purgative and diuretic in constipation, dyspepsia, and lithiasis.

3. Sodæ acetas, $NaC_2H_3O_2$. *D.* 10–30 grs. Made by acting on carbonate of sodium with acetic acid.

Properties.—Colourless crystals.

Used as a mild diuretic; but seldom given internally. Used in preparing other salts.

4. Sodæ sulphis, Na_2SO_3. *D.* 20–30 grs. Made by saturating carbonate of sodium with SO_2.

Properties.—White prisms, with odour of sulphur.

Used as an antiseptic in typhoid fever and pyæmia.

From hence is obtained:

(i.) Hyposulphite of soda, $Na_2S_2O_3$. *D.* 20–60 grs. Made by heating sulphite of sodium with sulphur.

Properties.—Large rhombic prisms, used as sulphite. Largely used in photography.

5. Soda tartarata, $KNaC_4H_4O_6$ *D.* 30 grs. as diuretic; 120 grs. as purgative (Rochelle salts). To a hot solution of sodium carbonate add acid tartrate of potash.

$$Na_2CO_3+2KHC_4H_4O_6=2KNaC_4H_4O_6+H_2O+CO_2.$$

Properties.—Colourless, transparent, right rhombic prisms.

Used as a diuretic in small, and a purge in larger doses. It is the active salt in Seidlitz powders, the doses given being 120 grs., with 40 grs. of bicarbonate of sodium in the blue paper, and 30 grs. of tartaric acid in the white.

6. Sodæ phosphas, Na_2HPO_4. *D.* 60 grs. as a diuretic; 1 oz. as a purge. Obtained from bone, by acting on it with sulphuric acid, when sulphate of lime and acid phosphate of lime is formed; if sodium carbonate be now added effervescence ensues, and a salt will be obtained on evaporation, which crystallizes with 12 parts of water.

(i.) $3(Ca_32PO_4)+6H_2SO_4=3(CaH_42PO_4)+6CaSO_4.$

(ii.) $3CaH_42PO_4+4Na_2CO_3=4Na_2HPO_4+Ca_32PO_4+4H_2O+4CO_2.$

Properties.—Transparent, colourless, rhombic prism; efflorescent, and tasting like common salt.

Used as a purgative and diuretic in constipation and lithic-acid diathesis.

7. Liquor sodæ chloratæ. *D.* 10–20 mins. Made by passing a stream of chlorine gas through a solution of carbonate of sodium.

Used as a disinfectant in bed-sores and malignancy.

Preparations.—*a.* Cataplasm sodæ chloratæ.

II. SODÆ NITRAS, $NaNO_3$.

Source.—Native.

Used in preparing nitric acid and arseniate of soda.

III. SODÆ SULPHAS, Na_2SO_4. *D.* ½–1 oz.
(Glauber's salts.)

$$NaCl+H_2SO_4=HCl+NaHSO_4.$$

Made in the preparation of hydrochloric acid.

To the acid sulphate thus produced add carbonate of soda. $2NaHSO_4+Na_2CO_3=2Na_2SO_4+CO_2+H_2O$.

Properties.—Colourless oblique prisms; efflorescent.

Used as a saline purge and diuretic.

IV. SODÆ BIBORAS (Borax), $Na_2B_4O_7$. *D.* 10–60 grs.

Occurs native. It is a biborate of soda.

Properties.—Transparent colourless crystals; slightly efflorescent.

Preparations.—*a.* Mel boracis.
b. Glycerinum boracis, 1 in 4.

Used as a diuretic, antacid, emmenagogue, refrigerant, and topical astringent in dyspepsia and sores about mouth.

V. SODÆ VALERIANAS. *See* Valerian.

POTASSIUM. K. 39. 1.

The metal is prepared by heating potashes K_2CO_3 and carbon to a high temperature in an iron retort. Carbonic oxide and potassium are formed, $K_2CO_3+C_2=K_2+3CO$.

The potassium distils over, and is collected in naphtha and not in water. Naphtha contains no oxygen, hence the metal cannot burn as it does when collected in water;

in which case the metal decomposes the water, uniting with the oxygen, and setting fire to the hydrogen.

Properties.—Potassium is a silver-white metal, yielding a purple flame when burnt.

Source of most of the compounds is :

I. Potassæ carbonas, K_2CO_3. *D.* 10–30 grs. Obtained from wood ashes by lixiviating, evaporating, and crystallizing.

Properties.—White, granular or crystalline; deliquescent.

Used as an antacid in dyspepsia and lithic acid diathesis.

From hence are derived:

1. Liquor potassæ, KHO. *D.* 20–60 mins. Obtained by adding slaked lime to the carbonate. $K_2CO_3+CaH_2O_2=2KHO+CaCO_3$.

Properties.—A clear alkaline liquid.

Used as an antacid, and externally as a caustic.

From hence is derived:

(i.) Potassa caustica. Made from liquor potassæ by evaporation.

Properties.—White pencils ; deliquescent.

Used as a caustic.

(ii.) Potassii iodidum, KI. *D.* 2–10 grs. Made by mixing and heating a solution of caustic potash with iodine.

$$6KHO+3I_2=5KI+KIO_3+3H_2O.$$

The iodate is now converted into the iodide by heating with charcoal.

$$2KIO_3+3C_2=2KI+6CO.$$

These reactions, represented separately, take place together.

Properties.—Colourless opaque cubic crystals, non-deliquescent.

Used as an alterative, discutient, and diuretic, in scrofula, syphilis, and gout, and as an emmenagogue in amenorrhœa. Used in excess it causes *iodism.*

Preparations:

a. Unguentum potassii iodidi; 64 grs. in 1oz. Lard, iodide and carbonate of potash.

b. Linimentum potassii iodidi cum sapone; 1 in 10. Iodide and carbonate of

potash, hard soap, oil of lemon, glycerine and water.

(iii.) Potassii bromidum, KBr. *D.* 5–60 grs. Made in exactly the same way as the iodide; insert Br_2 for I_2 throughout the equations.

Properties.—Colourless cubic crystals.

Used as a sedative, anæsthetic, alterative, aphrodisiac and in nervous affections.

2. Potassæ bicarbonas, $KHCO_3$. *D.* 10–30 grs. Made from carbonate of potash, by passing a stream of carbonic acid gas through the solution, $K_2CO_3+H_2O+CO_2=2KHCO_3$.

Properties.—Colourless prisms, not deliquescent.

Used as an antacid in lithic-acid diathesis.

Preparation.—*a.* Liquor potassæ effervescens. *Used* as a refrigerant and antacid.

3. Potassæ acetas, $KC_2H_3O_2$. *D.* 20 grs. as a diuretic; 2 drs. as a purgative. Made by dissolving carbonate of potash in acetic acid.

$$K_2CO_3+2C_2H_4O_2=2KC_2H_3O_2+H_2O+CO_2.$$

Properties.—White, satiny masses, deliquescent.

Used as a diuretic and purgative in rheumatism and dropsy.

4. Potassæ citras, $K_3C_6H_5O_7$. *D.* 20–60 grs. Made by neutralizing carbonate of potash by citric acid.

$$3K_2CO_3+2C_6H_8O_7=$$
$$2K_3C_6H_5O_7+3H_2O+3CO_2.$$

Properties.—White powder, deliquescent.

Used as an antacid, diuretic, and antiscorbutic in dyspepsia, rheumatism, and scurvy.

5. Potassæ chloras, $KClO_3$. *D.* 10–20 grs. Made by treating carbonate of potash with lime, whereby caustic potash is made (*see* Caustic Potash), and then passing chlorine gas through caustic solution.

$$3Cl_2+6KHO=KClO_3+5KCl+3H_2O.$$

The chlorate is separated from the chloride by crystallization.

Properties.—Colourless, crystalline plates.

Preparation.—*a.* Trochisci potassæ chloratis.

Used as a refrigerant and diuretic in low fevers and throat diseases.

From the chlorate we get—

(i.) Potassæ permanganas, $KMnO_4$, or $K_2Mn_2O_8$. by igniting, boiling, and neutralizing chlorate of potash, caustic potash, and dioxide of manganese.

$$KClO_3 + 6KHO + 3MnO_2 = 3K_2MnO_4 + KCl + 3H_2O.$$

The manganate is now converted into the permanganate by boiling in water.

$$3K_2MnO_4 + 2H_2O = K_2Mn_2O_8 + 4KHO + MnO_2.$$

Properties.—Purple, slender prisms.

a. Liquor potassæ permanganatis, dissolving in water 4 grs. to 1 fluid oz.

Used as a disinfectant, as Condy's Fluid.

6. Potassa sulphurata. *D.* 3–6 grs. Made by heating carbonate of potash and sulphur together.

Properties.—Greenish fragments.

a. Unguentum potassæ sulphuratæ. 1 in $15\frac{1}{2}$.

Used as a stimulant externally; and internally as a diaphoretic and expectorant.

II. Potassæ nitras, KNO_3. Saltpetre, nitre. *D.* 5–30 grs. Found native.

Properties.—Striated colourless prisms.

Used as a refrigerant, diuretic, and vascular sedative in rheumatism, dropsy, and febrile conditions.

From hence is derived

1. Potassæ sulphas, K_2SO_4. *D.* 15–60 grs. Obtained from nitric acid by acting on it with sulphuric acid, when the acid sulphate is formed. $KNO_3 + H_2SO_4 = HNO_3 + KHSO_4$. Add now carbonate of potash or lime.

$$2KHSO_4 + K_2CO_3 = 2K_2SO_4 + H_2O + CO_2.$$

Properties. — Colourless prisms; non-deliquescent.

Used as a purgative in dyspepsia and constipation.

III. Potassæ tartras acida, $KC_4H_5O_6$ (cream of tartar). *D.* 20–60 grs. as a diuretic; 2–4 drs. as a purgative. Made from argol, the deposit in wine casks, by heating with charcoal or pipeclay.

Properties.—White gritty powder, not deliquescent.
Used as as a refrigerant, diuretic, and purgative in fever and dropsy.

From hence is derived:

1. Potassæ tartras. $K_2C_4H_4O_6$. *D.* 1 dr.–1 oz. Made by neutralizing acid tartrate of potash with carbonate of potash.
$2KC_4H_5O_6+K_2CO_3=2K_2C_4H_4O_6+H_2O+CO_2$.
Properties.—Small four-sided prisms; deliquescent.
Used as an antacid and purgative in gouty or lithic-acid diathesis.

LITHIUM. L. 7.

Source.—Lepidolite, &c., which contain lithium in combination. The metal is obtained from the chloride in same way as barium, &c., by electric current.

Properties.—A white metal, and the lightest known.

I. Lithiæ carbonas. L_2CO_3. *D.* 3–6 grs., made from the native hydrate by dissolving in hydrochloric acid, and precipitating by carbonate of ammonia.
Used as a diuretic in gout, gravel, and renal calculus.

a. Liquor lithiæ effervescens. *D.* 5–10 oz., made by saturating a solution of carbonate of lithia with carbonic acid gas.

From hence is derived—

1. Lithiæ citras. $L_3C_6H_5O_7$. *D.* 5-10 grs., made by dissolving carbonate of lithia in citric acid.
Used as carbonate.

AMMONIUM. N.H$_4$. 18.

This radical has never been separated, but from the behaviour of the ammoniacal salts in their interchanges, there is no doubt left as to its existence.

Source of ammoniacal salts—coal. The nitrogen, contained in the more bituminous coals, unites during distillation in a retort, with hydrogen, forming NH_3, or ammoniacal gas, which is then passed through water, and thereby held in solution. To this is added hydrochloric acid, when there is precipitated.

I. Ammonii Chloridum. NH_4Cl. *D.* 5–30 grs.

By the addition of HCl to gas liquor.

$$NH_4HO+Cl=NH_4Cl+H_2O.$$

Properties.—Tough, colourless, and inodorous fibrous masses. Sometimes called sal-ammoniac.

Used as an alterative in rheumatism and chronic inflammation.

From hence is derived—

1. Ammonia, NH_3.

$$2NH_4Cl+CaH_2O_2=2NH_3+CaCl_2+2H_2O.$$

Hence the hydrate:

$$NH_3+H_2O=NH_4HO.$$

2. Ammoniæ carbonas, $2(NH_4)CO_3$. *D.* 3–10 grs. Made by heating a mixture of chalk and sal ammoniac. *See* Ammonia.

Properties.—This salt of ammonia is an unstable salt. It occurs in translucent crystalline masses.

Used as liquor ammoniæ.

a. Spiritus ammoniæ aromaticus (sal volatile). *D.* 20–60 mins. Made by distilling carbonate of ammonia and strong solution of ammonia, with oil of lemon, oil of nutmeg, rectified spirit, and water.

From hence is derived:—

(i.) Liquor ammoniæ acetatis. $NH_4C_2H_3O_2$. *D.* 2–6 drs. Made by neutralizing the carbonate of ammonia with acetic acid.

Used as a diaphoretic and refrigerant in febrile conditions; also in painful menstruation.

(ii.) Ammoniæ bicarbonas, NH_4HCO_3. *D.* 10–30grs. Made by exposing the carbonate to the air. Not officinal.

3. Liquor ammoniæ fortior. *D.* 3–10 mins. Made in the same way as free ammonia, and dissolving the gas in water.

Used as a stimulant, antacid, expectorant, rubefacient, and vesicant in syncope, dyspepsia, bronchitis, pneumonia, nervous diseases, and fever.

a. Linimentum camphoræ compositum (1 in 9). Mixing strong solution of ammonia with spirit, camphor, and oil of lavender.

b. Spiritus ammoniæ foetidus. *D.* ½–1 dr. (1 in 10.) Solution of ammonia, rectified spirit and assafœtida.

From hence is derived :

(i.) Liquor ammoniæ. *D.* 10–30 mins. (1 in 3.) Made by diluting the strong solution with water.

Properties.—A colourless liquid with pungent odour.

Used as the strong solution.

a. Linimentum ammoniæ. (1 in 4.) Solution of ammonia and olive oil.

From hence are derived :—

a. Liquor ammoniæ citratis $3(NH_4)C_6H_5O_7$. *D.* 2–6 dr. Made by adding citric acid to liquor ammoniæ.

Used as a diaphoretic or refrigerant in fevers.

β. Ammoniæ phosphas, $(NH_4)_2HPO_4$. *D.* 5–30 grs. Made by adding phosphoric acid to liquor ammoniæ.

Properties.—Colourless prismatic crystals.

Used as a diuretic in gout and urinary calculi.

γ. Ammonii bromidum, NH_4Br. *D.* 2–20 grs. Made by adding hydrobromic acid to liquor ammoniæ.

Properties.—Colourless crystals.

Used as bromide of potassium.

δ. Ammoniæ nitras, NH_4NO_3. Made by adding nitric acid to liquor ammoniæ.

Used in making nitrous oxide.

ε. Ammoniæ benzoas, $NH_4C_7H_5O_2$. *D.* 10-20 grs. Made by adding benzoic acid to liquor ammoniæ.

Properties.—Laminar crystals.

Used as benzoic acid.

ζ. Sulphide of ammonium. *D.* 3 mins. and upwards. Made by passing H_2S through liquor ammoniæ.

Properties.—A yellow liquid with disagreeable odour.

Used as a depressant, sudorific, and expectorant, and in rheumatism.

η. Ammonii iodidum, NH_4I.

BARIUM. Ba. 137.

Source of barium salts is either the sulphate, heavy spar, or witherite (the carbonate). The metal is prepared, however, by passing an electric current through a solution of the chloride.

Properties.—A brilliant white metal closely resembling calcium.

I. Barium carbonate or witherite, $BaCO_3$. Found native.

From hence is derived:—

1. Barii chloridum, $BaCl_2$. *D.* ½–2 grs. Made by heating barium carbonate with hydrochloric acid.

   Used sometimes as an alterative in glandular diseases. *Used* chiefly as a test.

Other salts not used medicinally are:—

1. Barium sulphate, $BaSO_4$. Found native, as heavy spar.
2. Barium sulphide, BaS. Made by heating the sulphate with coal.
3. Barium nitrate, $Ba2NO_3$. Made from the carbonate with nitric acid.
4. Barium monoxide, or baryta, BaO. Made by decomposing the nitrate by heat. When dissolved, it yields baryta water.
5. Barium dioxide, BaO_2. By gently heating the monoxide in a current of oxygen.

STRONTIUM. Sr. 87. 5.

The salts of strontium are not used in medicine.

Source.—The carbonate or sulphate. From the carbonate is obtained the chloride, and from a solution of the chloride the metal strontium is obtained by electric current. The oxide, SrO, is prepared from the nitrate by heat.

It will be seen that this exactly resembles barium, and closely resembles calcium, in all its properties. The chloride and nitrate being soluble salts, are used in preparing "red fire," as strontium imparts a crimson flame.

CALCIUM. Ca. 40.

Source of almost all calcium compounds is limestone, the carbonate of lime. The metal itself is prepared with great difficulty. It can be obtained by the decomposition of the chloride by the electric current, or by heating the iodide with sodium.

Properties.—A light yellow metal. It burns with a bright lime light, CaO being formed.

I. Calcium carbonate, $CaCO_3$. (Creta.) *Used* in producing CO_2.

II. Creta preparata. *D.* 20–60 grs. Chalk reduced to fine powder.

Used as an antacid, and as an astringent in dyspepsia and diarrhœa.

a. Mistura cretæ. *D.* 1–2 oz.

b. Pulvis cretæ aromaticus. *D.* 20–60 grs. (11 in 48.)

c. Pulvis cretæ aromaticus cum opio. *D.* 10–60 grs. (1 in 40.)

d. Chalk is contained in hydrargyrum cum creta.

From hence are derived:—

1. Calx, CaO; lime; quicklime. Made from chalk or limestone by burning in kilns.

Properties.— White masses absorbing water.

Used as a caustic.

From hence is derived:—

(i.) Calcis hydras. CaH_2O_2. Made by slaking lime with water. Heat is produced, and the lime shell crumbles and breaks down.

a. Liquor calcis. *D.* $\frac{1}{2}$–2 oz. ($\frac{1}{2}$ gr. in 1 oz.)

b. Liquor calcis saccharatus. *D.* 15–60 mins. (7·11 grs. in 1 oz.).

c. Linimentum calcis. (1 in 2.)

Equal parts of lime water and olive oil.

Carron oil consists of equal parts of lime water and linseed oil.

From hence is derived:—

a. Calx chlorata, $CaCl_2O_2$, $CaCl_2$. Chlorinated lime, commonly called chloride of lime or bleaching powder. It is a mixture of the hypochlorite and the chloride of calcium. Made by passing chlorine gas over hydrate of lime. The lime is spread

out in a chamber, and the gas passed over it until saturation occurs:

$$2CaH_2O_2+2Cl_2 = CaCl_2O_2CaCl_2+2H_2O.$$

Properties. — A dull white powder giving off chlorine.

Used as a disinfectant, and in the preparation of chloroform.

Preparations:

a. Liquor calcis chloratæ. (1 lb. in 1 gallon.) Chlorinated lime water.

b. Vapor chlori. (2 oz. of chlorinated lime moistened with water.)

Used as a disinfectant inhalation.

2. Calcii chloridum, $CaCl_2$. *D.* 10 grs. Made by dissolving chalk in hydrochloric acid:

$$CaCO_3+2HCl = CaCl_2+CO_2+H_2O.$$

Properties.—White deliquescent masses.

Used in glandular diseases.

From hence is derived:

(i.) Calcis carbonas precipitata. *D.* 10–60 grs. Made by adding excess of carbonate of soda to solution of calcium chloride:

$$CaCl_2+Na_2CO_3 = CaCO_3+2NaCl.$$

Used as chalk.

III. Calcis phosphas, Ca_32PO_4. *D.* 10–60 grs. Made by dissolving bone ash in hydrochloric acid. Bone ash is obtained by calcining bones. The chief salt in bones is phosphate of calcium:

$$Ca_32PO_4+4HCl = CaH_42PO_4+2CaCl_2.$$

Wash this precipitate of the acid phosphate of calcium with ammonia:

$$CaH_42PO_4+2CaCl_2+4NH_4HO= Ca_32PO_4+4NH_4Cl+4H_2O.$$

Used in rickets; and contained in pulvis antimonialis.

IV. Calcis hypophosphis. *D.* 5–10 grs. Made by heating together phosphorus and lime.

Properties.—White, pearly crystals.

Used as a nervine tonic and alterative in phthisis, &c.

V. Calcii sulphas, $CaSo_4$. (Plaster of Paris.) Found native.

Used as a test and in surgical dressings.

The following preparations are also important, but are not officinal :—

1. Calcium fluoride, CaF_2. Found in Derbyshire and Cumberland as fluor spar. *Used* as a flux.
2. Calcium sulphide, CaS. An insoluble salt formed in the soda ash process.

ALUMINIUM. Al. 27·5.

Source.—Alum schist. By exposing this to the air and washing with water the sulphate of aluminium and sulphate of iron are obtained in solution. On the addition of sulphate of ammonia alum crystallizes out. For preparation of the metal *see* below (3).

I. Alumen, alum. A double sulphate of aluminium and ammonium, $NH_4Al(So_4)_2$ with 12 parts of water of crystallization. *D.* 10–20 grs. as an astringent. *D.* 30–60 grains as a purgative.
 Properties.—Colourless octahedra.
 Used internally in small doses as an astringent, in large doses as a purgative.
 Preparation.—*a.* Alumen exsiccatum, dried alum. Made by drying alum at a moderate heat.
 Used as an escharotic.

The following salts are not officinal :—

1. Alumina, Al_2O_3, occurs native in the ruby, sapphire, and emery. Prepared by adding ammonia to solution of alum.
2. Aluminium chloride, Al_2Cl_6, made by heating alumina and charcoal in a stream of chlorine gas.
3. From aluminium chloride the metal aluminium is obtained by passing the vapour over metallic sodium.
 Properties.—A steel-grey colour, used on account of its lightness and bright lustre for optical purposes.
 Salts of aluminium are largely used for dyeing purposes and in glass and porcelain making.

Glass, Porcelain, &c.

There are four kinds of glass, differing according to salts used in manufacture.

1. Common green bottle-glass—composed of silicate of soda, lime, oxide of iron, and alumina.

2. Flint-glass or crystal—composed of silicate of potash and lead oxide.
3. Bohemian glass—composed of silicate of potash and lime.
4. Crown or window glass and plate glass—composed of silicate of soda and lime.

In making fine glass, the best materials must be used. Broken glass of the same kind as is being made is added to the ingredients in one quarter or half proportion. This broken mass is termed *cullet*. Glass, after it has been blown, must be allowed to *anneal*—*i.e.*, slowly to cool—otherwise it is useless, owing to its brittleness. Coloured matters are added to glass when it is wished to get variety in colour.

Ferrous oxide	produces	a deep green.
Oxide of manganese	,,	a purple tint.
Cobalt oxide	,,	a sapphire blue.
Cuprous oxide	,,	a ruby red.
Ferric oxide	,,	a yellow like topaz.

Porcelain and earthenwares consist of clays of various kinds. The salt forming the base is silicate of alumina. To make porcelain the finest china clays are used; for earthenware, common clay. The glaze on porcelain vessels is got from felspar, that in earthenware from common salt. The former resists acids, the latter is impervious to moisture but is acted on by acids.

Mordants.

Aluminia—*i.e.*, hydrate of aluminium—has great affinity for the fibre of cloth and vegetable colouring matters. To a solution of alum, add a solution of colouring liquid, such as aniline, logwood, cochineal, &c. On adding ammonia, a precipitate falls, carrying with it all the colouring matter. In the actual process of dyeing, the material to be dyed is first passed through a solution containing aluminia, and then through the colouring solution. In the first part of the process, the aluminia bites into the fibres, and in the second the aluminia selects and incorporates the colouring matter with the texture of the material. *Lakes* is the name given to the substance formed by aluminia and colouring matters.

CERIUM. Ce. 92.

Source.—Cerite, a silicate of cerium, iron, calcium, &c.

I. Cerii oxalas, CeC_2O_4. *D.* 1–2 grs. Made by boiling cerite in hydrochloric acid and adding oxalate of ammonia.

Used as a nervine tonic and sedative in vomiting from pregnancy.

II. Cerium oxide, and

III. Cerium nitrate have also been tried as medicines, but with no decided results.

CADMIUM. Cd. 112.

Source.—Cadmium sulphide, usually found along with zinc ore. During its distillation cadmium distils over first.

Properties.—A white metal closely resembling tin.

I. Cadmii iodidum. CdI_2. Made by bringing metallic cadmium and iodine together by digesting in water.

Properties.—Flat, pearly, micaceous scales.

Used as a rubefacient in cases of glandular diseases.

Preparations—

a. Unguentum cadmii iodidi. (1 in 8.)

MAGNESIUM. Mg. 24.

Source.—Magnesium is found most abundantly as magnesium limestone or dolomite, a double carbonate of magnesium and calcium. The metal is best prepared, however, from the chloride (*see* below) by heating with metallic sodium.

Properties.—A metal of a silver white colour, which burns readily, emitting a dazzling light.

I. Magnesiæ sulphas, $MgSO_4+7H_2O$. *D.* As an antacid, 20–60 grs.; as a purgative, 120 grs.–$\frac{1}{2}$ oz.; in combination with other medicines, 60 grs. Found as Epsom salts. It is, however, largely prepared from dolomite by treatment with sulphuric acid.

Properties.—Minute colourless rhombic prisms soluble in water.

Used as a saline, purgative, and diuretic in constipation, biliousness, and febrile conditions.

a. Enema magnesiæ sulphatis. Sulphate of magnesia, 1 oz,; olive oil, 1 oz.; mucilage of starch, 15 oz.

Used as a purgative.

b. Also contained in mistura sennæ composita.

From hence are derived:

1. Magnesiæ carbonas, $MgCO_3$. *D.* As an antacid, 10 grs.; as a purge, 20–60 grs. Heavy carbonate of magnesia, "Magnesite," is prepared for medicinal purposes from the sulphate by precipitating the sulphate of magnesia with carbonate of soda in hot concentrated solutions.

$$MgSO_4+Na_2CO_3=MgCO_3+Na_2SO_4.$$

This formula is not exactly correct, as there is always more or less of the oxide united with the carbonate, thus: $MgCO_3,MgH_2O_2,4H_2O$, having four parts water in combination.

Properties.—A white granular powder, insoluble in water, soluble in acid.

Used as an antacid and saline purgative in dyspepsia and constipation.

a. Liquor magnesiæ carbonatis. *D.* 1–2 oz. Made by saturating a solution of the carbonate with carbonic acid gas.

b. Liquor magnesiæ citratis. *D.* 5–10 oz. Made by dissolving carbonate of magnesia in citric acid, adding syrup of lemon and bicarbonate of potash.

From hence is obtained:

(i.) Magnesia, MgO. *D.* As an antacid, 10–20 grs.; as a purgative, 20–60 grs. The heavy oxide. Made by heating some of the carbonate in a porcelain crucible.

2. Magnesiæ carbonas levis. *D.* Same as heavy. Made in the same way as the heavy, only using cold dilute solutions instead of hot.

$$4MgSO_4+4Na_2CO_3+H_2O=$$
$$3MgCO_3,MgH_2O_2+4Na_2SO_4+CO_2.$$

Properties.—The light carbonate occupies $3\frac{1}{2}$ times the bulk of the heavy.

Used as heavy.

From hence is obtained:

(i.) Magnesia levis, MgO. *D.* Same as heavy. By decomposing the light carbonate by heat.

$3MgCO_3\ MgH_2O_24 = MgO + H_2O + 3\ CO_2$.

Used as the heavy oxide. The remaining salts are not used medicinally.

1. Magnesium chloride, $MgCl_2$. Made by heating a solution of magnesia in hydrochloric acid. This salt is also found free in sea water, and is the source from which the metal is prepared.
2. Ammonio-magnesia phosphate. Add to a solution of sulphate of magnesium, or any salt of magnesium, a solution of carbonate of ammonia and phosphate of sodium, and an insoluble double phosphate is formed, $MgNH_4PO_4$. This is the triple phosphate so commonly met with in vesical calculi.

ZINCUM. Zn. 65.

Source.—Zinc ores. Blende is the sulphide, ZnS; calamine is the carbonate, $ZnCO_3$; and a third ore is the red oxide. To obtain the metal, roast the sulphide or carbonate, and the oxide is formed; then mix with charcoal, and heat in a retort and the metal is obtained.

Properties.—A bluish white metal, brittle at ordinary temperatures, but when heated to 30°C. it can then be hammered out.

Used to coat iron, when it is said to be galvanized. It forms an alloy with copper constituting brass, and with nickel and copper form German silver.

I. Granulated zinc. Made by fusing and pouring zinc into water.

From hence are derived:

1. Zinci chloridum, $ZnCl_2$. Zinc and hydrochloric acid.

   $Zn + 2HCl = ZnCl_2 + H_2$.

   To free this from the iron contained in it, mix with a solution of chlorine, afterwards adding carbonate of zinc, and evaporate.

   Used as an antiseptic, escharotic, and irritant in cancers, ulcers, and nævi.

a. Liquor zinci chloridi, made in same way as above, but not evaporating.

2. Zinci sulphas, $ZnSO_4$, white vitriol. *D.* 1–10 grs. as a tonic. *D.* 10–30 grs. as an emetic. Zinc and sulphuric acid and purifying, as in the case of the chloride.

$$Zn+H_2SO_4=Zn\,SO_4+H_2.$$

Properties.—Colourless, transparent prisms.

Used externally as an astringent in wounds, ulcers, &c. Internally as an emetic; and as an astringent and nervous tonic in nervous diseases.

From hence are derived:

(i.) Zinci valerianas, from sulphate of zinc and valerianate of soda.

(ii.) Zinci carbonas, $ZnCO_3$. *D.* 1–10 grs. Sulphate of zinc and carbonate of soda. This salt is, however, a mixture of the carbonate and hydrate of zinc, and should be written: $ZnCO_32ZnH_2O_2$.

$$3ZnSO_4+2H_2O+3Na_2CO_3=$$
$$ZnCO_32ZnH_2O_2+2CO_2+3Na_2SO_4.$$

Used in much the same way as the sulphate, only it is less irritating; it does act as an emetic. It is chiefly used as a tonic.

From hence are derived:

(*a.*) Zinci oxidum, ZnO. *D.* 1–10 grs., made by heating the carbonate.

$$ZnCO_32ZnH_2O_2=3ZnO+2H_2O+CO_2.$$

Properties.—A pale yellow colour.

Used externally much the same as sulphate and carbonate, only it is less irritating.

a. Unguentum zinci. (1 in $6\frac{1}{2}$.) Zinc oxide and benzoated lard.

(β). Zinci acetas, $Zn2(C_2H_3O_2.)$ *D.* 1–2 grs. as a tonic, 10–20 grs. as an emetic; made by dissolving carbonate of zinc in acetic acid.

$$ZnCO_32ZnH_2O_2+6C_2H_4O_2=$$
$$3(Zn2C_2H_3O_2)+5H_2O+CO_2.$$

Properties.—Thin crystalline plates with pearly lustre.

Used as the sulphate.

CUPRUM. Cu. 63·5.

Source.—The copper ores :

1. From the red oxide, Cu_2O, by reduction in a current of hydrogen.
2. From the carbonate or malachite, by reducing with carbon and silica in a furnace.
3. Copper pyrites, a compound of copper, sulphur, and iron, by roasting with sand and silica.
4. Cupric sulphide, CuS.

Properties.—A deep red colour, ductile, and malleable; it gives a green tint to hydrogen flame. It forms many alloys, amongst others brass, an alloy containing two-thirds of copper and one-third of zinc. Bronze, gun and bell metal are other alloys of tin and copper.

I. Cuprum, in the form of foil, is used in chemistry for many purposes.

From hence are obtained:

1. Cupri sulphas, $CuSO_4$. Blue vitriol. *D.* ½–2 grs. as a tonic. *D.* 5–8 grs. as an emetic. By heating copper and sulphuric acid together. $2H_2SO_4+Cu=CuSO_4+SO_2+2H_2O$, or by roasting iron pyrites.

Properties.—Blue crystals.

Used externally as an astringent, and as an escharotic, internally, emetic, astringent, and tonic.

From hence are derived:

(i.) Anhydrous sulphate of copper, by heating the sulphate to 400° F.

(ii.) Ammonia-sulphate of copper solution. Made by adding ammonia to sulphate of copper. Used as a test.

2. Subacetate of copper. Verdigris.

$$(C_2H_3O_2)_2Cu_2O.$$

Made by acting on copper plates with acetic acid, or with acid tartrate of potash. Sometimes by copper exposed to the action of "the fermenting ware"—*i.e.*, refuse grape husks.

Properties.—A green-grey colour, used as an escharotic, and as a test. A solution of subacetate of copper is also used as a test.

The following salts are not made use of medicinally :

I. Cuprous oxide (red oxide), Cu_2O, found native, used in colouring glass.
II. Cupric oxide, CuO. Made by heating copper in the air; from hence many of the copper salts can be obtained.
III. Cupric nitrate, $Cu2(NO_3)$. Blue. Made from nitric acid and copper.
IV. Cupric chloride, $CuCl_2$. Green. Made from copper and chlorine gas.
V. Cupric sulphide, CuS. Black. Made by passing hydrogen over an acidified solution of a copper salt.
VI. Cupric carbonate, $CuCO_3$. Green. Made by adding an alkaline carbonate to a solution of a copper salt.
VII. Cupric arsenite or Scheele's green. Made from arsenite of soda and cupric sulphate.

HYDRARGYRUM. Hg. 200.

Source.—Native sulphide, HgS, called cinnabar. The metal is easily obtained by roasting the ore, when the sulphur burns off as the dioxide, and the metal volatilizes, and its vapour is condensed in earthen pipes.

Mercury is the only metal liquid at the ordinary temperature. Its boiling point is 350° Fahr.

Used in the process of extracting gold and silver from their ores, and for silvering mirrors, &c.

I. Mercury.

a. Pilula hydrargyri. *D.* 3–8 grs. (1 in 3.) Mixing mercury with liquorice root and confection of roses.

b. Hydrargyrum cum creta. *D.* 3–8 grs. (1 in 3.) Mercury and chalk.

Used in the diarrhœa of children.

c. Unguentum hydrargyri. (1 in 2.)

d. Unguentum hydrargyri compositum. (1 in $4\frac{1}{2}$.)

e. Emplastrum hydrargyri. (1 in 3.)

f. Emplastrum ammoniaci cum hydrargyro. (1 in 5.)

g. Suppositoria hydrargyri. (1 in 6.)

h. Linimentum hydrargyri. (1 in 9.)

Used as an alterative in syphilis, congestion of liver, rheumatism, inflammation of blood-vessels and serous surfaces. Applied externally in joint diseases and syphilis.

From hence are derived:

1. Hydrargyri iodidum viride, HgI. *D.* 1–3 grs. Rubbing iodine and mercury together in presence of rectified spirit.
   Properties.—A yellow or dull green powder.
   Used in skin diseases.
2. Hydrargyrum sulphuretum, HgS. Triturating mercury with sulphur.
3. Liquor hydrargyri nitratis acidus. Dissolving mercury in cold dilute nitric acid and boiling.

$$Hg_3+8HNO_3=3Hg(NO_3)_2+4H_2O+N_2O_2.$$

Used as a caustic in cancer, &c.

a. Unguentum hydrargyri nitratis. (1 in $15\frac{1}{2}$.) *Used* as a stimulant in diseases of the eye.

From hence is derived:

(i.) Hydrargyri oxidum rubrum. Triturate together mercury and mercuric nitrate and heat.

$$Hg(N_2O_3)_2+Hg=2HgO+2N_2O_4.$$

Used as an escharotic in ulcers and fungous growths.

a. Unguentum hydrargyri oxidi rubri. (1 in 8.)

4. Hydrargyri sulphas, $HgSO_4$. Dissolving mercury in hot H_2SO_4 and drying.

$$Hg+2H_2SO_4=HgSO_4+SO_2+2H_2O.$$

Used in preparing other salts.

Hence is derived:

(i.) Hydrargyri subchloridum, HgCl. Calomel. *D.* $\frac{1}{2}$–2 grs. as an alterative. *D.* 2–6 grs. as a purgative. Mercury, sulphate of mercury, rubbed together with chloride of sodium and subliming.

$$HgSO_4+Hg=Hg_2SO_4$$

The mercurous sulphate is by this means made into mercuric sulphate.

$$Hg_2SO_4+2NaCl=Na_2SO_4+2HgCl.$$

Properties.—A dull white powder, insoluble

in water, spirit, or ether; it sublimes with heat.

a. Lotio hydrargyri nigra. Black wash (30 grs. in 10 oz., *i.e.*, 1 dr. in 1 pint). Adding solution of lime to calomel.

$$2HgCl + CaH_2O_2 = Hg_2O + CaCl_2 + H_2O.$$

This forms mercurous or black oxide.

b. Unguentum hydrargyri subchloridi. (1 in $6\frac{1}{2}$.)

c. Pilula hydrargyri subchloridi composita. *D.* 5–10 grs. (1 in 5). Antimony, calomel, guaiacum resin, and castor oil.

(ii.) Hydrargyri perchloridum, $HgCl_2$. *D.* $\frac{1}{20}$–$\frac{1}{4}$ gr. Corrosive sublimate. Triturate sulphate of mercury, chloride of sodium and black oxide of manganese, and sublime.

$$HgSO_4 + 2NaCl = Na_2SO_4 + HgCl_2.$$

The mercuric sulphate frequently contains some of the mercurous sulphate, which the chloride of sodium changes into calomel; and to prevent this, black oxide of manganese is added, which, with the excess of common salt, generates some free chlorine.

Properties.—Heavy colourless masses and prismatic crystals soluble in 20 parts of cold water; more soluble in alcohol; most soluble, however, in ether. Chloride of ammonium added to the water increases its solubility.

a. Lotio hydrargyri flava (18 grs. in 10 oz.) made by mixing corrosive sublimate with lime water.

$$HgCl_2 + CaH_2O_2 = HgO + CaCl_2 + H_2O.$$

This forms the yellow oxide.

b. Liquor hydrargyri perchloridi. *D.* $\frac{1}{2}$—2 dr. ($\frac{1}{2}$ gr. in 1 oz.) made by dissolving corrosive sublimate with chloride of ammonia.

From hence are derived:

(*a*) Hydrargyrum ammoniatum, made by precipitating perchloride of mercury with ammonia.

$$HgCl_2+2NH_4HO=$$
$$NH_4HgCl+NH_4Cl+2H_2O.$$

Properties.—This forms the white precipitate or ammonio-chloride of mercury. An opaque white powder; insoluble in ordinary solvents.

Used as an escharotic and in the treatment of pediculi.

a. Unguentum hydrargyri ammoniati. (1 in 8.)

β. Hydrargyri iodidi rubrum. *D.* $\frac{1}{16}$—$\frac{1}{4}$ grs. Precipitating hot solution of perchloride of mercury with iodide of potassium.

$$HgCl_2+2KI=HgI_2+2KCl.$$

Properties.—A crystalline powder, vermilion in colour, almost insoluble in water.

Used as an alterative in syphilis.

a. Unguentum hydrargyri iodidi rubri. (1 in 28.)

BISMUTHUM. Bi. 210.

Source.—Found native; also as the sulphide from which it is readily reduced.

Properties.—A pinkish white metal, fusing readily.

I. Bismuthum purificatum. Bismuth is purified by forming a slag of its impurities, by heating with nitrate of potash.

From hence is obtained:

1. Bismuthi subnitras. *D.* 5–10 grs. Made by adding nitric acid to bismuth.

$$Bi_2+8HNO_3=2(Bi3NO_3)+2NO+4H_2O.$$

This is the nitrate; pour this into water and the subnitrate falls.

$$Bi3NO_3+H_2O=BiNO_4+2HNO_3.$$

Properties.—A heavy white powder in crystalline scales.

Used as an antacid and sedative in dyspepsia and diarrhœa.

a. Trochisci bismuthi, 2 grains in each.

From hence are derived:

(i.) Bismuthi oxidum, Bi_2O_3. *D.* 5–15 grs. Made by precipitation from subnitrate of bismuth by boiling in solution of soda.

Properties.—A dull lemon yellow powder.

Used as subnitrate.

(ii.) Bismuthi carbonas, Bi_2CO_5. *D.* 5–20 grs. Made by precipitation from the nitrate of bismuth (as prepared above) with carbonate of ammonia.

Properties.—A white powder insoluble in water.

Used as subnitrate.

II. Liquor bismuthi et ammoniæ citratis. *D.* $\frac{1}{2}$–$1\frac{1}{2}$ dr. Made by dissolving bismuth in nitric acid and adding citric acid and ammonia until the precipitate is dissolved.

Properties.—A colourless saline solution.

Used as subnitrate.

ARGENTUM. Ag. 108.

Source.—Sulphide of silver, which exists along with sulphide of lead, as galena. The galena is melted and slowly cooled; crystals of lead separate, and are raked out, and thus an alloy rich in silver is obtained. From this, by cupellation, the metal is extracted, by roasting in a current of air, whereby the lead oxidizes, and is removed as litharge; pure silver remaining.

Properties.—White and malleable; conducts heat and electricity well. Silver forms alloys with various metals; one important alloy is with mercury, and this fact is made use of by some refiners to obtain the pure metal from its salts. With copper it forms an alloy used in coinage and in making plate articles.

I. Argentum purificatum.

Used in coating pills.

From hence are derived:

1. Argenti nitras, $AgNO_3$. *D.* $\frac{1}{4}$–$\frac{1}{2}$ gr. Made by dissolving silver in nitric acid.

Properties.—Colourless tabular crystals or in white sticks.

Used internally as an astringent and alterative in epilepsy, gastric and enteric affections; externally as an irritant, vesicant,

and escharotic in the treatment of wounds and ulcers.

From hence is derived :

(i.) Argenti oxidum, Ag_2O. *D.* ½–2 grs. Made by precipitating a solution of the nitrate with lime water.

Properties.—An olive brown powder.

Used as an astringent in hæmorrhage, and as nitrate.

2. Chloride of silver; sometimes used as a remedy.

AURUM. Au. 197.

Source.—Gold occurs in the free state as nuggets, or in sand. From the latter it is washed out, and then picked up by mercury to form an alloy.

I. Solution of the chloride of gold. Dissolve gold in aqua regia, and then add distilled water.

Properties.—A clear orange-coloured liquid.

Used as a test for atropine.

Aqua regia consists of one part nitric and three parts hydrochloric acid.

PLATINUM. Pt. 197·6.

Source.—Occurs native, combined with certain metals—palladium, iridium, &c. The metal is obtained by dissolving the ore in aqua regia (nitro-hydrochloric acid), and adding chloride of ammonium, when a precipitate of the chloride of platinum is formed; this, when heated and hammered out, yields the metal.

Properties.—A bright white metal, extremely difficult to fuse, and can only be melted by the oxy-hydrogen blowpipe. It is not acted on by ordinary acids, hence it is much used in the laboratory.

Used in medicine as a test in the form of the solution of the perchloride of platinum.

This salt is made by acting on platinum with nitro-hydrochloric acid, and dissolving the chloride.

Platinum has two oxides, PtO and PtO_2.

STANNUM. Sn. 118.

Source.—Tinstone. This is a stannic oxide found in Cornwall, &c. From this the metal is obtained by heating with charcoal, and then hammering out.

Properties.—White, soft, malleable, and ductile.

Used in making tin foil, tin plate, tin tacks, pewter, Britannia metal, solder, bell and gun metal, and bronze.

I. Granulated tin. Made by fusing tin and pouring it into cold water.

Used sometimes medicinally to dislodge the round worm; tin is chiefly used to make:

1. Solution of chloride of tin, $SnCl_4$. Made by dissolving tin in hydrochloric acid.

   Used principally to test mercury. Its therapeutic value is considered as nothing, but it has been given in nervous affections, and in chronic skin diseases.

The oxides are two:

1. Stannic oxide, SnO_2 Native tin-stone.
2. Stannous oxide, SnO.

Stannate salts are used as mordants.

LEAD. Pb. (Plumbum). 207.

Source.—Lead sulphide, galena. This is roasted in a reverberatory furnace, with addition of a small quantity of lime, to form a fusible slag with any siliceous matter that may be present. By the action of the air the lead sulphide is converted into sulphate, whilst, in a further stage, the sulphur burns off as sulphuric dioxide, and lead oxide is left behind:

1. $PbS + O_4 = PbSO_4$.
2. $PbSO_4 + PbS = 2PbO + 2SO_2$.

The SO_2 is now burnt off and PbO left:

3. $2PbO + PbS = 3Pb + SO_2$.

Properties.—It is a bluish-white metal, soft and pliable; it melts at 334°, oxidizes when exposed to air, and is soluble in water, especially when nitrates or chlorides are contained in the water; free carbonic acid also adds to its solubility, and these are important points to remember in connexion with water-pipes. To demonstrate the presence of lead in water, pass H_2S through it, and a brownish tint condemns the water as unfit to drink.

From lead are obtained the following:—

I. Plumbi oxidum, PbO. Litharge. Massicot. By heating lead in a current of air.

Properties.— A brick-red colour, and occurring as scales.

Used for making plasters:

a. Emplastrum plumbi. Heating oxide of lead with olive oil and water.

A second oxide, red oxide, or red lead, or minium, Pb_3O_4, is made by exposing litharge to the air at a moderate heat. This oxide is chiefly used in glass making.

A third oxide of lead is the lead dioxide, a puce-coloured oxide, PbO_2. Made by acting on red lead with nitric acid.

From hence is derived:

1. Plumbi acetas, $Pb(C_2H_3O_2)_2$. *D.* $\frac{1}{2}$–3 grs. Dissolve oxide of lead in acetic acid:

$$PbO+2C_2H_4O_2 = Pb(C_2H_3O_2)_2+H_2O.$$

Properties.—White crystalline masses.

Used as an astringent in dysentery, phthisis and hæmorrhage. Used largely as an external application in skin diseases.

a. Unguentum plumbi acetas. (1 in 37½.)

b. Pilula plumbi cum opio. *D.* 4–8 grs. (3 grs. of acetate of lead and $\frac{1}{2}$ gr. of opium in 4 grs.)

c. Suppositoria plumbi composita. (3 grs. of acetate and 1 gr. opium in each.)

From hence is derived:

(i.) Liquor plumbi subacetatis. $Pb_2O(C_2H_3O_2)_2$. From acetate of lead, by boiling in water with oxide of lead.

(*a*) Liquor plumbi subacetatis dilutus. (1 in 40.) Commonly called Goulard's water.

(*b*) Unguentum plumbi subacetatis compositum.

Used as a mild astringent and sedative in various forms of injuries and diseases of the skin.

II. Plumbi carbonas, $PbCO_3$. White lead. Made by exposing thin sheets of lead in earthen pots containing acetic acid; thus forming lead acetate. The pots are packed on a floor, in a bed of stable manure or spent tan, and, by the fumes of the fermenting tan, the acetate is converted into the carbonate.

Properties.—A heavy, white powder, insoluble in water.

Used as an external astringent in skin diseases.

a. Unguentum plumbi carbonas. (1 in 8.)

III. Plumbi nitras, $Pb(NO_3)_2$. By dissolving lead in boiling nitric acid.

Properties.—Colourless octahédral crystals.

Used in onychia.

From hence is derived:

1. Plumbi iodidum, PbI_2. *D.* $\frac{1}{4}$–1 gr. Nitrate of lead and iodide of potassium:

$$Pb(NO_3)_2 + 2\,KI = PbI_2 + 2KNO_3.$$

Properties.—Bright yellow scales.

a. Emplastrum plumbi iodidi. (1 in 9.)

b. Unguentum plumbi iodidi. (1 in 8.)

Used.—Both internally and externally in scrofula, but not extensively.

FERRUM. Fe. 56.

Most of the iron in this country is obtained from clay ironstone, an impure ferrum carbonate combined with much clay. Iron is obtained from this by processes of roasting, whereby the carbonate is reduced to the oxide; by the addition of coal the oxide is reduced to the pure metal, and by the addition of limestone, slag is formed, thus carrying off the sand, clay, &c. These processes happen together, as the coal and limestone are thrown along with the clay ironstone into a blast furnace.

From this furnace "cast iron" or pig iron is drawn off. This can be converted into "wrought iron" by the process of puddling, which consists in burning out about five per cent. of carbon, silica and other impurities. Steel is obtained from wrought iron by heating in charcoal; whereby the iron becomes impregnated with one or two per cent. of carbon.

Of late years the Bessemer process has taken precedence of others in the making of steel. By this method cast iron is converted at once into steel. Iron is introduced for medicinal purposes as iron wire, and from hence a number of salts and preparations are made.

I. Iron wire (ferrum).

a. Mistura ferri aromatica. *D.* 1–2 oz. Digest iron wire, and flavour with cinchona, calumba, cloves, cardamoms, orange-peel, and peppermint-water. (1 gr. in 1 pint.)

b. Vinum ferri. *D.* 1–2 drs. Digest iron wire in sherry.

Used as a hæmatinic in anæmia.

From iron wire are obtained:—

1. Ferri iodidum, FeI_2. *D.* 1–5 grs. Made by boiling iodine and iron wire together.
Properties.—Green crystalline, deliquescent.
Used as an alterative in scrofula and syphilis.
a. Syrupus ferri iodidi. *D.* 20–60 mins. ($4\frac{1}{2}$ grs. in 1 dr.)
b. Pilula ferri iodidi. *D.* 3–8 grs. (1 in 3.)

2. Ferri perchloridi liquor fortior. *D.* 3–10 mins. (3–17 grs. in 1 oz.) From iron wire and hydrochloric acid, and subsequent addition of nitric acid to oxidize. In this process $FeCl_2$ the ferrous chloride, is formed, and then the ferric, by the presence of nitric acid.

$$6FeCl_2+2HNO_3+6HCl= \\ 3\,Fe_2Cl_6+N_2O_2+4H_2O.$$

Properties.—An orange brown liquid.
a. Liquor ferri perchloridi. *D.* 10–40 mins. (1 in 3.) Water and strong solution.
b. Tinctura ferri perchloridi. *D.* 10–40 mins. (1 in 3), rectified spirit and strong solution.
Used as a hæmatinic and astringent.

3. Ferri pernitratis liquor. *D.* 10–40 mins. (7–8 grs. in 1 oz.) Made by dissolving iron wire in nitric acid.
Properties.—A reddish brown liquid.
Used as a hæmatinic and astringent.

4. Ferri sulphas, $FeSO_4$. Ferrous sulphate. *D.* 1–5 grs. Made by dissolving iron wire in hot sulphuric acid.

$$Fe+H_2SO_4=FeSO_4+H_2.$$

Properties.—Pale greenish rhombic prisms.
Used as a hæmatinic.

From hence are derived:

(i.) Ferri sulphas exsiccata. *D.* $\frac{1}{2}$–3 grs. Made by heating $FeSO_4$ to 400° and pulverizing.
Properties.—A whitish powder.
Used as a hæmatinic and astringent.

(ii.) Ferri sulphas granulata. *D.* 1–5 grs. Made by pouring a hot solution of $FeSO_4$ into rectified spirit.
Properties.—Greenish crystals.
Used as a hæmatinic and astringent.

(iii.) Ferri carbonas saccharata. *D.* 5–20 grs. Precipitating sulphate of iron with carbonate of ammonia and rubbing with sugar. The sugar protects the salts from oxidation.

$$FeSO_4+(NH_4)_2CO_3=(NH_4)_2SO_4+FeCO_3.$$

Properties.—Small grey coloured lumps.
a. Pilula ferri carbonatis (4 in 5). *D.* 5–20 grs.
b. Mistura ferri composita. *D.* 1–2 oz. (Griffiths' mixture.) This mixture contains carbonate of iron, but is made directly from the sulphate. Add sulphate of iron to a soapy emulsion made by rubbing together carbonate of potash, myrrh, sugar, spirits of nutmeg, and rose water. In this process the following occurs:—

$$FeSO_4+K_2CO_3=FeCO_3+K_2SO_4.$$

Must be kept in a glass stoppered bottle.
Used as a hæmatinic.

(iv.) Ferri arsenias, $Fe_3As_2O_8$. *D.* $\frac{1}{10}$–$\frac{1}{8}$ gr. Made by precipitating a mixed solution of arseniate and acetate of soda, with sulphate of iron and washing.

$$3FeSO_4+2Na_2HAsO_4+2NaC_2H_3O_2=$$
$$Fe_3As_2O_8+3Na_2SO_4+2C_2H_4O_2.$$

Properties.—A green amorphous powder.
Used as an alterative tonic and escharotic in skin diseases.

(v.) Ferri phosphas, $Fe_3P_2O_8$. *D.* 5–10 grs. Made by precipitating a mixed solution

of the phosphate and acetate of soda with sulphate of iron :

$$3FeSO_4+2Na_2HPO_4+2NaC_2H_3O_2 = Fe_3P_2O_8+3Na_2SO_4+2C_2H_4O_2.$$

Properties.—A slate blue amorphous powder.

Used as a hæmatinic in diabetes and rickets.

a. Syrupus ferri phosphatis. (1 gr. in 1 dr.) *D.* 1 dr.

(vi.) Liquor ferri persulphatis. Made by adding to sulphate of iron boiling solutions of sulphuric and nitric acids :

$$6FeSO_4+3H_2SO_4+2HNO_3= 3(Fe_23SO_4)+N_2O_2+4H_2O.$$

Properties.—Dense, dark-reddish brown liquid.

From hence are derived :

(*a*) Ferri acetas, $Fe_26(C_2H_3O_2)$.

Exhibited as

a. Tinctura ferri acetatis. *D.* 5–30 mins. Made by adding alcohol and acetate of potash to a solution of the perchloride of iron.

$$Fe_23SO_4+6KC_2H_3O_2 = Fe_26(C_2H_3O_2)+3K_2SO_4.$$

Used as a hæmatinic.

(*β*) Ferri oxidum magneticum. *D.* 5–10 grs. Made from a solution of the proto- and per-sulphate of iron by precipitating with a solution of soda and drying.

Properties.—Brownish black powder.

Used as a hæmatinic.

(*γ*) Ferri peroxidum humidum, Fe_26HO, *D.*, ad lib. Made by adding soda to a solution of persulphate of iron :

$$Fe_23SO_4+6NaHO=Fe_26HO+3Na_2SO_4.$$

Properties.—Moist, reddish-brown, pasty mass.

Used as an antidote to poisoning by arsenic.

(*δ*) Ferri peroxidum hydratum, Fe_2O_22HO. *D.* 10–60 grs.

Properties.—Reddish-brown powder.
Used as a hæmatinic tonic.
a. Emplastrum ferri. Chalybeate plaster.
Used in tic-douloureux and neuralgia.
From hence are derived;

(α) Ferrum redactum. *D.* 1–5 grs. Made by passing dry hydrogen gas over the hydrated peroxide.
Used as a hæmatinic.
a. Trochisci ferri redacti. (1 gr. in each.)

(β) Ferrum tartaratum. Ferri potassio-tartras. *D.* 5–20 grs. Made by dissolving hydrated peroxide of iron in a solution of acid tartrate of potash.
Properties.—Garnet scales.
Used as a hæmatinic.

(γ) Ferri et ammoniæ citras. *D.* 5–10 grs. Made by dissolving hydrated peroxide of iron in hot citric acid, and neutralizing with ammonia.
Properties.—Thin scales of a hyacinth red colour.
Used as a hæmatinic.
a. Vinum ferri citratis. *D.* 1–4 dr. Made with orange wine. (8 grs. in 1 dr.)

(δ) Ferri et quiniæ citras. *D.* 5–20 grs. Made by dissolving the hydrated peroxide of iron with quinine and citric acid, and adding ammonia.
Properties.—Thin scales of a golden-yellow colour.
Used as a hæmatinic.

MANGANESIUM. Mn. 55.

Source.—The black oxide of manganese, from which the metal can be obtained by heating with charcoal.

I. Manganesii oxidum nigrum, MnO_2. Native salt.
Used in preparing chlorine, and as an oxidizing agent in many preparations.
Other preparations are not officinal.
Numerous oxides exist:
MnO. Mn_2O_3. Mn_3O_4. MnO_2 (black oxide).
The most important salts are:—

1. The sulphate, $MnSO_4$:

$$2MnO_2+2H_2SO_4=2MnSO_4+2H_2O+O_2.$$

2. The chloride, $MnCl_2$:

$$MnO_2+4HCl = MnCl_2+2H_2O+Cl_2.$$

3. The manganate of potash, K_2MnO_4: *See* Potassium.
4. The permanganate, $K_2Mn_2O_8$: *See* Potassium.

ANTIMONIUM. Sb. (Stibium). 122.

Source.—Antimony occurs in Nature, chiefly as Sb_2S_3. This salt, when freed from earthy impurities, is called crude or black antimony. The metal is obtained from the sulphide by roasting, and then reducing with charcoal and carbonate of sodium.

Properties.—A bright, bluish-white metal, very brittle, insoluble in dilute hydrochloric or sulphuric acids.

Used in the arts to make type metal, Britannia metal, and pewter.

I. Antimonium nigrum (black sulphide), Sb_2S_3. Native. When purified, it is greyish black and crystalline.

1. Antimonium sulphuratum, Sb_2S_3. *D.* 1–5 grs. Made by boiling the black sulphide with soda, and precipitating with dilute sulphuric acid:

$$2Sb_2S_3+6NaHO=2\ Na_3SbS_3+Sb_2O_3+3H_2O.$$

Now add sulphuric acid;

$$2Na_3SbS_3+3H_2SO_4=3Na_2SO_4+Sb_2S_3+3H_2S.$$

In the first reaction sulph-antimonite of sodium is formed, and in the second, this salt is acted on by sulphuric acid.

Properties.—A bright orange-red powder, insoluble in water.

Used as an alterative. It is contained in pilula hydrargyri subchloridi composita.

From hence is derived:

(i.) Antimonii chloridi liquor:

Solution of terchloride of antimony, $SbCl_3$, dissolved in hydrochloric acid:

$$Sb_2S_3+6HCl=2SbCl_3+3H_2S.$$

Known as butter of antimony.

Properties.—A heavy, yellowish-red liquid.

Used as an escharotic in cancer and fungous growths.

From hence is obtained:

(*a*) Antimonii oxidum, Sb_2O_3. *D.* 1–5 grs. Made by pouring the solution of the terchloride into water rendered alkaline by carbonate of soda.

Properties.—A greyish white powder, insoluble in water; soluble in HCl.

Used for the same purposes as the other antimonial salts.

a. Pulvis antimonialis (1 in 3). *D.* 3–15 grs. Oxide of antimony, 1; phosphate of lime, 2. Intended as a substitute for "James's Powder."

From hence is obtained:

(*a*) Antimonium tartaratum, $KSbC_4H_4O_7$. Antimonii potassio - tartras, tartar emetic. *D.* as a diaphoretic and expectorant, $\frac{1}{16}$–$\frac{1}{6}$ gr.; as a vascular depressant and sedative, $\frac{1}{6}$–2 grs.; as an emetic, 1–3 grs. Made by boiling oxide of antimony with acid tartrate of potash.

$$2KHC_4H_4O_6 + Sb_2O_3 = 2KSbC_4H_4O_7 + H_2O.$$

Properties.—Colourless transparent crystals, that have a tendency to effervesce to a slight extent. Tartar emetic is soluble in twenty parts of cold water and in two parts of boiling water.

Used as an emetic, vascular depressant, alterative, sedative, and diaphoretic in fevers and inflammations, &c.

a. Vinum antimoniale (2 grs. in 1 oz.) *D.* 15–40 mins. Dissolve, 40 grs. of tartarated antimony in 1 pint sherry.

b. Unguentum antimonii tartarati (1 in 5). Mix together quarter ounce of finely powdered tartarated antimony with 1 ounce of simple ointment.

The oxides of antimony:

1. Sb_2O_3. Officinal and mentioned above.

2. Sb_2O_5. Non-officinal. Made by acting on metallic antimony with nitric acid.
3. Sb_2O_3, Sb_2O_5. An intermediate oxide, non-officinal. Made by heating the metal in the air.

ARSENICUM. As. 75.

Source.—Arsenical ores. The arseniurets are frequently met with in Nature, the commonest being the arsenio-sulphide of iron. On roasting this mineral in the air, oxygen combines with the arsenic, and arsenious acid distils over. On heating the oxide with charcoal, the metal arsenic is obtained.

Properties.—Arsenic possesses a brilliant grey lustre; it burns with a bluish flame forming the oxide.

From the arsenio-sulphide of iron are obtained:

I. Acidum arseniosum, As_2O_3. *D.* $\frac{1}{60}$–$\frac{1}{12}$ gr. Obtained by roasting the mineral arsenio-sulphide of iron, and afterwards purifying by re-volatilizing and condensing the vapour of the arsenious acid, on a cold surface.

Properties.—Arsenious acid occurs as a heavy white powder, or in sublimed porcelainous masses.

Used as an alterative and tonic in skin diseases, cholera, and pulmonary affections; also as an escharotic and antiseptic.

a. Liquor arsenicalis (4 grs. in 1 oz. or $\frac{1}{24}$ gr. in 5 mins.) *D.* 2–10 mins. Made by dissolving arsenious acid in a solution of the carbonate of potash and colouring with tincture of lavender. Sometimes called Fowler's solution or liquor potassæ-arsenitis.

Properties.—A pink alkaline solution.

b. Liquor arsenici hydrochloricus (4 grs. in 1 oz.). *D.* 2–10 mins. Made by boiling arsenious acid with dilute hydrochloric acid. No decomposition occurs.

Properties.—A colourless acid liquid.

Used as arsenious acid.

Hence is derived:

1. Sodæ arsenias, Na_2HAsO_4. *D.* $\frac{1}{12}$–$\frac{1}{2}$ gr. Made by fusing arsenious acid with the

nitrate and carbonate of soda. This salt contains 7 parts water of crystallization.

$$As_2O_3 + 2NaNO_3 + Na_2CO_3 = Na_4As_2O_7 + N_2O_3 + CO_2$$

Properties.—Colourless transparent crystals.
Used as arsenious acid.
This salt may be deprived of its water of crystallization by heating to 300°. Dose of dried salt $\frac{1}{20}$–$\frac{1}{4}$ gr.

a. Liquor sodæ arseniatis (4 grains in 1 oz.) *D.* 2–10 mins. Made by dissolving the dried arseniate of soda in water.

2. Ferri arsenias (*see* Iron). Non-officinal—Arsenici et hydrargyri hydriodatis liquor. *D.* 10–30 mins. Donovan's solution. Made by rubbing pure mercury, pure arsenic, and pure iodine together in the presence of rectified spirit.

Properties.—A pale green liquid.
Used in syphilitic affections of the skin.

Arsenic possesses important salts not used in medicine.

1. Arsenic acid, As_2O_5. Made by boiling arsenious acid, As_2O_3, with nitric acid, until all red fumes are gone. A solution of As_2O_5 is obtained, $As_2O_5 + 3H_2O = 2H_3AsO_4$. Salts belonging to this group are called arseniates. The acid is used as an oxidizing agent in the manufacture of magenta.
   a. Arseniate of sodium (*see* Soda).
2. Arseniuretted hydrogen, AsH_3. Made by decomposing an alloy of arsenic and zinc with sulphuric acid. Obtained in testing for arsenic by Marsh's test.
3. Arsenic combines with chlorine, bromine, and iodine, forming corresponding salts.
4. Sulphides of arsenic.
   a. As_2S_2, realgar, occurs in Nature.
   b. As_2S_3, orpiment, a yellow powder made by passing H_2S through a solution of As_2O_5.

Arsenical salts are largely used as paints and as colouring materials.

PRACTICAL CHEMISTRY.

A. To detect metallic bases in the solid state, or in solution, where only one metal is sought for :—

The first thing to be done, if the substance to be tested be a solid, is to get a solution of it in distilled water, or, failing that, in one of the mineral acids. If the substance is contained in a thick or muddy liquid, this should first be filtered in order to get as clear a fluid as possible to work with. The principle of all the tables given here is that nearly all the metals form insoluble compounds with some of the re-agents used, and, by adding these re-agents in the order given here, we can determine the group to which any given substance belongs. The chemical symbols for the metals and compounds are given.

Group I.—Insoluble Chlorides.

Add HCl.—A white precipitate may
indicate Ag,
" Pb,
" Hg (mercurous salts only),
" Sb.

N.B.—Lead is not thrown down in weak solutions, as chloride of lead is slightly soluble in water; the antimonic oxychloride is immediately re-dissolved on adding slight excess of HCl.

Distinguishing Tests.

Add NH_4HO to the white precipitate :
If it *dissolves*, it is Ag;
If it *blackens*, it is Hg;
If it is unchanged, it is Pb.

Confirmatory Tests.

a. Ag. 1. Add to original solution :
$K_2Cr_2O_7$ = a brick-red precipitate of bichromate of silver.
2. Heat the dried AgCl in the blowpipe flame with a little Na_2CO_3 on charcoal = white malleable beads of silver.

Pb. 1. Add to original solution KI = brilliant yellow spangles of PbI_2.
2. Add to O.S.* $K_2Cr_2O_7$ = yellow precipitate of $PbCr_2O_7$, or chrome yellow.
3. Heat in blowpipe flame, as in previous case = soft malleable beads of Pb.

* O. S., "original solution."

Hg. 1. Boil original precipitate in its tube with clean copper wire, or foil = a grey deposit, becoming silvery on drying and rubbing on a piece of cloth.

2. Heat the dried precipitate on platinum foil = it volatilizes completely.

GROUP II.—Sulphides insoluble in an acid solution.

Add $HCl + H_2S$ in solution :—

Black ppt. : Hg(ic.) (mercuric) Cu. Pb.	Black ppt. : Au. Pt.
Brown ppt. : Bi.	Brown ppt. : Sn(ous.).
Yellow ppt. : Cd.	Yellow ppt. : As. Sn(ic.). Orange : Sb.
All the above are insoluble in $(NH_4)_2S$.	All the above are soluble in $(NH_4)_2S$.

N.B.—Where lead is present in minute quantities, as in drinking water, it is necessary to evaporate the solution to small bulk, and pass a constant stream of H_2S gas for some hours through the fluid.

Distinguishing Tests.

A. Black precipitates :

To original solution add dilute H_2SO_4, a white precipitate = Pb.
To O. S.* add KHO, a deep blue colour = Cu.
„ O. S. „ NaHO, a yellow ppt. = Hg.
„ O. S. „ $FeSO_4$, ppt., a black = Au.
„ O. S. „ KCl and alcohol, a yellow ppt. = Pt.

To original solution evaporated to a small bulk add H_2O in large quantity, a white ppt. = Bi.

B. Yellow precipitates :

To O. S. add NH_4HO { No effect = As. White ppt. = Sn.
„ O. S. add NH_4HO and $(NH_4)_2S$, No effect = Cd.

* O. S., "original solution."

C. Orange precipitate is characteristic of Sb.
D. Brown precipitates.—Given with the black precipitates. $Sn^{(ic.)}$, soluble in $NH_4HO + (NH_4)_2S$.

Confirmatory Tests for the Chief Metals.

Pb. *See* previous group.

Hg. 1. Boil O. S.,* to which one-sixth part of HCl has been added, with clean copper wire or foil. A grey deposit is formed on the copper, which, on being dried and rubbed on cloth, becomes silvery.

2. Add to O. S. some solution of KI; a scarlet precipitate, easily soluble in excess of KI, is formed (iodide of mercury).

As. 1. *Reinsch's Test:* Add one-sixth part HCl to O. S., and boil with clean copper wire. A steel-grey deposit is formed on the copper. Dry and heat the copper in a clean test tube or piece of tubing; crystals of oxide of arsenic are formed in the cool part of the tube.

2. *Marsh's Test:* Generate free hydrogen gas by the action of dilute sulphuric acid on zinc in a glass bottle or tube with an appropriate aperture of outlet for the gas. Carefully wait until all the air has been expelled, and apply a light to the escaping hydrogen—if air is present in the apparatus there will be an explosion—if the hydrogen burns satisfactorily, place over the flame a clean porcelain dish. No stain should be formed on it if all the re-agents are pure. Next introduce the suspected material, and if arsenic is present it will unite with the nascent hydrogen to form AsH_3. Light the escaping gas, and again apply the porcelain plate to the flame. Arsenic is deposited as a metallic stain, soluble in a solution of calcic chloride.

3. Add a mixture of ammonia and sulphate of copper solution to O. S.; a green colour is produced—Scheele's green, or arsenite of copper.

Sb. 1. *Reinsch's Test,* as with *As.* There is a violet-coloured deposit on the copper.

2. *Marsh's Test,* as with *As.* The deposit on porcelain is *sooty,* and insoluble in calcic chloride.

* O. S., "original solution."

GROUP III.—Sulphides insoluble in an alkaline solution.

Add $NH_4HO + NH_4Cl + (NH_4)_2S$.

Black	Green	Flesh coloured	White
ppt.	ppt.	ppt.	ppt.
Fe.	Cr.	Mn.	Zn.
Ni.			Al.
Co.			(The Al. precipitate is a hydrate, not a sulphide.)

Distinguishing Tests.

Black precipitates.

Add NaHO to O. S.*; a dirty green ppt. = Fe (ous)
„ „ „ a rust coloured ppt. = Fe (ic)
„ „ „ light green = Ni
„ „ „ sky blue = Co.

Ferrous salts are further indicated by giving a blue precipitate with ferrocyanide of potassium. Ferric salts give a blood-red colour with sulphocyanate of potassium.

White precipitates.

Add NaHO to O. S. till ppt. first formed re-dissolves, and to this solution add—

H_2S, a white ppt. = Zn.

Add NaHO to O. S. till ppt. first formed re-dissolves, and to this solution add—

NH_4Cl, a white ppt. = Al.

Green and flesh-coloured precipitates sufficiently indicate Cr and Mn.

GROUP IV.—(Chlorides and sulphides, soluble, but carbonates insoluble.)

Add $NH_4HO + NH_4Cl + (NH_4)_2CO_3$.

White precipitates.

Indicate, Ba, Sr, or Ca.

Add solution of $CaSO_4$ to O_1S.

Immediate white precipitate = Ba.
A white precipitate, appearing slowly = Sr.
No precipitate = Ca.
Barium compounds, colour flame green.
Strontium „ „ „ crimson.
Calcium „ „ „ red.

* O. S., "original solution."

Group V.

Add Na_2HPO_4 to O. S.; a white precipitate indicates Mg.

N.B.—NH_4Cl is added to solution, to prevent carbonate of magnesia being thrown down with the previous groups.

Group VI.

This contains three common bases, the compounds of which are all very soluble; these are K, Na, and (NH_4). To detect these add:—

1. KHO and heat.

If NH_4 is present, ammonia is set free, and can be detected by its smell, by its vapour turning red litmus paper blue, and by the dense white fumes formed when a glass rod, moistened with HCl is held over the escaping gas.

2. Add a strong solution of tartaric acid to O. S. in a watch-glass. Ammonia being excluded by the above test, a white precipitate slowly forming at the bottom of the glass, indicates K. Flame test gives violet colour.

3. Evaporate O. S. to dryness, and ignite residue with alcohol. A yellow-coloured flame indicates sodium.

Tests for the Chief Acids, free, and combined with Metals.

Group I.—Decomposed by strong acids.

1. Carbonates. Effervesce on addition of acid. CO_2 set free, which is odourless, colourless, not combustible, or a supporter of combustion, and turns lime water milky, owing to the formation of $CaCO_3$.

2. Sulphides. On the addition of HCl or H_2SO_4, H_2S is given off. This gas is known by the strong odour of rotten eggs, and by blackening paper dipped in a solution of acetate of lead.

3. Sulphites. On heating with HCl, SO_2 is evolved, which has the odour of burning sulphur, and forms an acid (H_2SO_3) with H_2O.

4. Chlorates. On heating with HCl, chlorine gas is given off, known by its yellow colour, pungent odour, and bleaching properties. Chlorates deflagrate when heated in charcoal.

5. Cyanides. When HCl is added and heated, HCy is given off, known by the "bitter almond odour;" the vapour caught in an inverted watch-glass containing some solution of $AgNO_3$, gives a white precipitate of cyanide of silver.

Boil with KHO in excess, add $FeSO_4$ and HCl, when, if a cyanide is present, prussian blue is formed.

Evaporate original solution with $(NH_4)_2S$, and on cooling, add Fe_2Cl_6, when a blood-red colour (sulpho-cyanate of iron) is produced.

GROUP II.—Precipitated by $BaCl_2$.

1. Sulphates. Thrown down as insoluble barium sulphate.

Fuse precipitate on charcoal with Na_2CO_3, and add HCl. H_2S is evolved.

Sulphuric acid is an oily liquid, which decomposes when heated into H_2O, SO_2 and oxygen.

2. Oxalates. Thrown down as barium oxalate; soluble in HCl and HNO_3.

Oxalates give a precipitate with lime water and solution of $CaSO_4$.

Oxalic acid is decomposed by heat or strong sulphuric acid into H_2O, CO and CO_2, without charring.

3. Citrates. Thrown down as barium citrate, which is soluble in HCl and HNO_3.

Charred on heating, or on adding strong H_2SO_4.

No precipitate with lime water until boiled.

4. Tartrates. Thrown down as barium tartrate which is soluble in HCl and HNO_3.

Charred on heating, with strong odour of caramel (burned sugar).

Strong solution of tartaric acid precipitates potassium and ammonium salts.

Precipitate with $CaCl_2$, or lime water.

GROUP III.—Precipitated by $AgNO_3$.

1. Chlorides. Thrown down as a curdy white chloride soluble in ammonia, but insoluble in HNO_3.

Add MnO_2+HCl, chlorine is given off.

$4HCl+MnO_2=Cl_2+MnCl_2+2H_2O$. Free HCl with NH_3 gives off dense white fumes of NH_4Cl.

2. Bromides. Same tests as chlorides, but colour of bromine brown. Bromide of silver, yellowish white.

3. Iodides. Same tests as chlorine. Free iodine volatilizes as a purple vapour, settling down as brown metallic scales, forms with starch, blue iodide of starch.

Iodide of silver, yellow in colour.

4. Acetates. In strong solution thrown down as white acetate of silver. Fe_2Cl_6 gives deep red colour,

Add C_2H_6O (alcohol) and H_2SO_4, and heat, when the odour of acetic ether can be detected.

Free acetic acid volatilizes without residue, on the application of heat, giving a strong odour of vinegar.

GROUP IV.—All the salts soluble.

Nitrates. Deflagrate on charcoal when heated.

Add H_2SO_4 in equal parts to solution, and cool the mixture; then pour down the side of the test tube some solution of $FeSO_4$, when an olive-brown ring between the liquids indicates the presence of nitrate.

Nitric acid turns organic matter (the skin, white paper, &c.) yellow; it fumes on exposure to air, and when added to copper, gives off dense brown fumes.

ORGANIC CHEMISTRY.

By organic chemistry is meant the chemistry of the compositions of secretions or productions of plants and animals. As carbon forms the base, essence, or starting-point of all these compounds, the details may be summed up as a chemical history of carbon in its combinations. Carbon is a tetrad or tetratomic element, it therefore requires four elements of a monad element, such as hydrogen, to satisfy it, forming CH_4; or when again C, unites with a dyad, say O, it requires two molecules forming CO_2. In this manner the multitude of possible compounds are made up, either by four atoms of a monad, or three atoms of one monad and one atom of another: as ($CHCl_3$) and so on, may combine and form definite series of compounds. In exact chemical writings the nature of the element, whether monad, dyad, triad, &c., ought to be inscribed, and as a ready means of so doing the following is used.

H' monad, O'' dyad, N''' triad, C'''' tetrad.

These quantities should be written in compounds, thus: $H'_2O'', C''''O''_2, N'''H'_3$.

In *organic chemistry* the *radical* of the substance *is* not a simple metal or element, but *a compound radical;* thus in C_2H_6O, ethyl alcohol, the radical is C_2H_5. This compound may be regarded as water $\left.\begin{matrix}H\\H\end{matrix}\right\} O$ in which one atom of hydrogen is replaced by the radical C_2H_5= $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\} O$= ethyl alcohol.

The compound radical is not a *fixed quantity*, but groups and series of compounds arise as the radical replaces a monad, dyad, or triad. Thus when C combines with H we find certain definite and stable compounds built upon varying radicals.

$\left.\begin{matrix} H \\ H \end{matrix}\right\}$ insert compound radical $\left.\begin{matrix} CH_3 \\ H \end{matrix}\right\}$ Monocarbonic or methyl series.

$\left.\begin{matrix} H \\ H \end{matrix}\right\}$ insert compound radical $\left.\begin{matrix} C_2H_5 \\ H \end{matrix}\right\}$ Dicarbonic or ethyl series.

$\left.\begin{matrix} H \\ H \end{matrix}\right\}$ insert compound radical $\left.\begin{matrix} C_3H_7 \\ H \end{matrix}\right\}$ Tricarbonic or propyl series.

These various series have each compounds peculiar to themselves, and the groups are daily extended.

We shall now take up these groups in detail, and chiefly consider those substances that are most important pharmaceutically.

A. Monocarbonic or Methyl Series.

The radical is CH_3; and we have already seen how it can replace an atom of hydrogen and act as a monad.

The type of this group is *methyl alcohol* $\left.\begin{matrix} CH_3 \\ H \end{matrix}\right\} O$. This looks like water $\left.\begin{matrix} H \\ H \end{matrix}\right\} O$ in which one atom of H is replaced by CH_3.

I. Methyl alcohol is obtained during the dry distillation of wood, hence it is termed wood spirit. The crude wood spirit first obtained contains not pure methyl alcohol, but methyl oxalate, which by treatment with water is decomposed and the spirit is obtained. It is a colourless fluid, burns with a non-luminous flame. Sp. gr. ·8142 at 0° C. and it boils at 66° C.

Spirit of wine containing 10 per cent. of wood spirit is known as methylated spirit, so largely used by manufacturers, &c. It is duty-free and non-drinkable from its nauseous taste and odour.

Belonging to this group we have methyl hydride, or *marsh gas*, $\left.\begin{matrix} CH_3 \\ H \end{matrix}\right\}$ already discussed.

A more important compound is:—

II. Chloroformum, $CHCl_3$. *D.* 3–10 mins. Made by distilling rectified spirit with chlorinated lime, slaked lime, and chloride of lime, and washing with sulphuric acid.

Properties.—Sp. gr. 1·49. Limpid, colourless liquid, with characteristic taste and odour. Burns with a green smoky flame.

Preparations.—*a.* Linimentum chloroformi (1 in 2). Chloroform and camphor liniment.

b. Spiritus chloroformi. *D.* 10–30 mins. (1 in 20). Chloroform and rectified spirit.

c. Tincturi chloroformi composita. *D.* 20–60 mins. (1 in 10). Chloroform, rectified spirit, and tincture of cardamoms.

d. Aqua chloroformi. *D.* $\frac{1}{2}$–2 dr. (1 dr. in 25 ozs. water).

Used as an anæsthetic, narcotic, anti-spasmodic, and diaphoretic, in surgical operations, spasmodic affections and nervous irritability. Used externally as a stimulant and diaphoretic in skin diseases and neuralgia (*see* Anæsthetics).

B. Dicarbonic or Ethyl Series.

Radical C_2H_5. This series is the most important of all; its starting-point is ethyl alcohol, C_2H_5HO, or C_2H_6O, or $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}O$=alcohol.

I. Alcohol is prepared from sugar by what is termed the vinous fermentation (*see* Ferments). Alcohol and carbonic acid being the chief products.

VARIETIES OF ALCOHOL.

1. Spiritus rectificatus.—This is spirit of wine or rectified spirit; it is obtained from the weak spirit, by concentrating, by distillation, until it contains 84 per cent. by weight of pure alcohol. Sp. gr. 0·838 at 60° F.

   Used as a stimulant; and in the preparation of many tinctures.

   Absolute or real alcohol.—An excess of water can be removed from alcohol by washing with carbonate of potash and lime. Sp. gr. 0·7938.

2. Spiritus tenuior. Proof spirit (5 in 8) containing 49 per cent. by weight of alcohol. Sp. gr. 0·920 at 60° F.

   Used largely in preparation of tinctures.

3. Spiritus vini gallici; brandy. *D.* 1–2 ozs. Contains 40–50 per cent. of alcohol. Whisky is of nearly the same strength.

a. Mistura spiritus vini gallici. *D.* 1–9 ozs. One part brandy, one part cinnamon water, with yolk of egg and sugar.

4. Vinum xericum; sherry. Obtained by fermentation from grape juice to which varying amounts of brandy are added. Contains about 17 per cent. of alcohol.
5. Claret and hock (not officinal) contains from 7–9 per cent. alcohol.
6. Strong ale and porter (not officinal) from 6–1.

II. Ether, C_4H_{10} or $\left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O$. *D.* 20–60 mins. H_2O in which both atoms are replaced by C_2H_5.

Preparation.—Ether is prepared from alcohol by distilling with sulphuric acid. The process, however, is complicated, and consists of two stages.

$$1.\ C_2H_6O+H_2SO_4=C_2H_6SO_4+H_2O.$$

Alcohol + sulphuric acid = hydric-ethyl-sulphate + water. Hydric-ethyl-sulphate is also termed sulphovinic acid.

$$2.\ C_2H_6SO_4+C_2H_6O=C_4H_{10}O+H_2SO_4.$$

sulphovinic acid+alcohol=ether+sulphuric acid. The sulphovinic acid coming in contact with a second molecule of alcohol causes this interchange, and so on the process goes, sulphuric acid being ready again to act on alcohol. This process is called the *continuous etherification process.* Owing, however, to secondary reactions occurring the process is limited.

Ether purus.—To purify the ether thus obtained, shake up ether with chloride of lime and slaked lime for a time, when pure ether will be found floating on the surface.

Properties.—Sp. gr. 0·735. Boiling point 105° Fahr. Vapour very heavy, nearly three times as heavy as air; inflammable, not miscible with water.

Used as an anæsthetic in surgical operations, also as a stimulant and external refrigerant in flatulence and inflammatory conditions.

Preparations.—*a.* Spiritus ætheris. *D.* $\frac{1}{2}$–$1\frac{1}{2}$ dr. (1 in 3), mixing ether with rectified spirit.

III. Spiritus ætheris nitrosi, $C_2H_5NO_2$. *D.* $\frac{1}{2}$–2 oz. This might be described as a preparation of ether, except that it is derived from sulphuric acid and alcohol directly.

$$C_2H_6O+HNO_3+H_2SO_4+Cu= \\ C_2H_5NO_2+CuSO_4+2H_2O.$$

Alcohol + nitric acid + sulphuric acid + copper = nitrous ether + copper sulphate + water.

Properties.—Spirit of nitrous ether is transparent, with slight yellow tinge, and an apple-like odour. Sp. gr. 845.

Used as a stimulant, diaphoretic, and diuretic in fevers and dropsies.

IV. Ether aceticus, $C_2H_5C_2H_3O_2$. *D.* 20–60 mins. Made by distilling rectified spirit with acetate of soda and sulphuric acid.

Used as a stimulant and antispasmodic.

V. Many ethyl compounds are known, such as ethyl phosphates, nitrates, chlorides, sulphides, sulphates, &c.

Besides these two more common monatomic carbon series we have—

C. Tricarbon series with radical C_3H_7.

The compounds belonging to this group are termed propyl: thus propyl alcohol, $\left.\begin{matrix}C_3H_7\\H\end{matrix}\right\}O$.

D. Tetracarbon Series. Radical C_4H_9. Compounds are called butyl: thus butyl alcohol, $\left.\begin{matrix}C_4H_9\\H\end{matrix}\right\}O$.

E. Pentacarbon Series.—Radical C_5H_{11}. Compounds are called amyl: thus amyl alcohol, $\left.\begin{matrix}C_5H_{11}\\H\end{matrix}\right\}O$. This is the chief constituent of fusel oil obtained chiefly in potato spirit.

F. Many higher alcohols exist having radicals of high quantities, thus, melisyl alcohol $\left.\begin{matrix}C_{30}H_{61}\\H\end{matrix}\right\}O$, a substance found in wax.

From Alcohol, by Oxidation, many Compounds are obtained.

In the first place, if alcohol be exposed to oxidizing agents, it becomes changed into aldehyd, C_2H_4O, and acetic acid $C_2H_4O_2$. Thus—

$$2MnO_2 + 2H_2SO_4 = O_2 + 2MnSO_4 + 2H_2O.$$

The oxygen thus set free acts on alcohol

$$2C_2H_6O + O_2 = 2C_2H_4O + 2H_2O.$$

The aldehyd C_2H_4O absorbs O rapidly and forms

$$2C_2H_4O + O_2 = 2C_2H_4O_2 = \text{acetic acid}.$$

Various series of compounds are formed.

1. Monocarbon series. Formic acid, C_2H_2O.
2. Dicarbon series:

   a. Aldehyd, C_2H_4O. *See* above.

Belonging to the same series we have:

b. Acetic acid, $C_2H_4O_2$. Acetic acid.

c. Chloral hydras, C_2HCl_3O. *D*. 10–30 grs. Made by saturating absolute alcohol with chlorine gas, and then purifying, and adding water. The alcohol is first oxidized and forms aldehyd and water, $C_2H_6O+O_2=2C_2H_4O+2H_2O$.

Chlorine acting on aldehyd gives chloral.

$$C_2H_4O+3Cl_2=C_2HCl_3O+3HCl.$$

Properties.—Chloral occurs as white crystals with pungent odour.

Used as a soporific anodyne and hypnotic in sleeplessness, asthma, &c.

Preparation:

a. Syrupus chloral. *D*. 1–3 drs. (10 grs. in 1 dr.) Mix with water and syrup.

Numerous acids result from bodies called glycols, or bodies following the type $\left.\begin{matrix}H_2\\H_2\end{matrix}\right\}O_2$. Two series result, one known as the lactic acid series, the other as the oxalic series.

I. In the lactic acid series we have—

a. Carbonic acid, $\left.\begin{matrix}CO\\H_2\end{matrix}\right\}O_2$.

b. Lactic acid, $\left.\begin{matrix}C_3H_4O\\H_2\end{matrix}\right\}O_2$. This acid is contained in sour milk produced by the lactic fermentation.

II. Oxalic acid series:

a. Oxalic acid, $\left.\begin{matrix}C_2O_2\\H_2\end{matrix}\right\}O_2$ obtained from juice of many plants.

b. Succinic acid, obtained by distillation from amber. Connected intimately with this acid we have malic acid, found in many ripe fruits, and tartaric acid, found chiefly in grapes and tamarinds (*see* Tartaric Acid).

Cyanogen. Cn or Cy. 27.

Cyanogen is prepared by heating the cyanide of mercury or of silver, when it is given off as a colourless gas, burning, when ignited, with a peach-blossom coloured flame.

Cyanogen is named from κύανος, blue, in allusion to its forming prussian blue with iron salts. The history of its preparation is shortly this :—

1. Ferrocyanide of potassium, K_4FeCy_6, is produced (*see* Potassium).
2. From this salt the cyanides are prepared; the most common is cyanide of potassium,

$$2K_4FeCy_6+2K_2CO_3=10KCy+2KCyO+Fe_2+2CO_2.$$

So mercuric cyanide is prepared from the same salt, by heating with mercuric sulphate.

3. From this cyanide, Cy is obtained by heat.

Starch and Sugar.

A. Starch. Amylum $C_6H_{10}O_5$.

Starch is chiefly obtained from potatoes and wheat.

a. Potato-starch is prepared by mashing raw potatoes into a fine pulp. Collecting the pulp on muslin and letting water run slowly over it; the starch granules are washed through the muslin, and may be collected for use or examination.

b. Wheat-starch (amylum, B. P.) may be prepared by wrapping flour in calico, and kneading, whilst a slow stream of water is passing over it. The starch granules pass through the calico, and can be collected. In the calico, sticky materials remain, termed gluten. Indigo is added to starch, making it blue for laundry purposes, to prevent linen coming out yellow when washed. Starch is easily recognized by the blue colour it gives with iodine, forming iodide of starch, or by the appearance the granules present under the microscope. Each granule seems to be coiled round a central axis, which appears black in the centre.

Preparations (*see* Graminiceæ).

c. In addition to above we have starch derived from beetroot, millet, sago, and Indian corn.

B. Dextrin.

Add to a weak solution of starch a few drops of sulphuric acid and boil; or, again, heat starch to 320° F., when the same substance is produced in both cases—viz., a substance that gives none of the starch reactions and

is termed dextrin. A solution of this substance is termed British gum, and used as a vehicle in calico printing. The same effect is produced by adding diastase to solutions of starch.

C. Malt.

Barley, when steeped and softened in water, allowed to germinate slightly, and further change arrested by heating in a kiln, is termed malt. Barley consists of starch and gluten. Gluten is the substance which gives tenacity to bread; it is a mixture of vegetable fibrin, casein and gluten.

Gluten, during the malting process, becomes *diastase*, the peculiar ferment of malt, and this, reacting on the starch, converts it into dextrin. The further process in making alcohol consists in dextrin becoming grape-sugar, and finally alcohol.

D. Sugar.

1. Cane-sugar (sucrose), $C_{12}H_{22}O_{11}$.—Sugar is prepared by crushing sugar-cane between rollers, by which means the juice is expressed. This is at once heated, and a small quantity of lime is added to precipitate the albumen. The juice is then boiled down in copper pans until it becomes thick, filtered through linen, again evaporated to a syrup, and allow to cool. As it cools, crystals of sugar are deposited. The residue is again evaporated, and again allowed to cool and deposit crystals. The dark-coloured fluid that remains is termed molasses or treacle.

Sugar is again refined when brought to this country.

2. Grape-sugar (dextrose glucose), $C_6H_{12}O_6$, is found in many fruits, and is excreted in large quantity in diabetic urine.

Cane-sugar is convertible into grape sugar, thus:—

$$C_{12}H_{22}O_{11}+H_2O=2C_6H_{12}O_6.$$

This is brought about in presence of yeast, when dextrose and levulose, that is, grape-sugar and fruit-sugar, are formed, both having the same formula. Grape-sugar or dextrose is formed in many ways:—

a. By boiling starch or dextrine with dilute acids.

b. By the action of malt on starch.

c. By the action of dilute acids upon cane-sugar.

Another method of converting cane into grape-sugar is employed as a test for sugar. Dissolve a few grains of

cane-sugar in water, add a drop or two of dilute H_2SO_4; boil for ten minutes; then add a few drops of sulphate of copper, and a considerable quantity of solution of potash; heat these to boiling, when a yellowish-red precipitate of cuprous oxide falls. This test, without the addition of H_2SO_4, is used as a test for grape-sugar.

3. Levulose, fruit-sugar, or left-hand glucose. The names, dextrose right-hand glucose, and levulose left-hand glucose, imply the effect each has upon polarized light. Some turn the plane to the left, some to the right. Thus cane-sugar, grape-sugar, milk-sugar, dextrine, and starch all turn it to the right; whereas fruit-sugar and galactose turn it to the left.

4. Lactose, milk-sugar, is also a sucrose, $C_{12}H_{22}O_{11}$, and occurs only in milk, from the whey of which it is obtained by evaporation. Dilute acids convert it into galactose. Lactose, when oxidized, yields muric, saccharic, tartaric and oxalic acids, not convertible into alcohol.

Fermentation.

Fermentation depends upon the presence and growth of ferments. Ferments are living organisms, which by their action produce a chemical change in certain fluids. There are numerous ferments, both vegetable and animal, but the common are :—

1. The alcoholic fermentation.—Grape-sugar, in the presence of yeast, undergoes fermentation; carbonic acid escaping in bubbles, and alcohol remaining in the liquid. Yeast is the cerevisiæ fermentum, B.P., and acts best at a temperature of 70°—75° F. The yeast will be found, after the change, to have increased in quantity.

The change that occurs is as follows :—

$$\begin{array}{ccccc} C_6H_{12}O_6 & = & 2C_2H_6O & + & 2CO_2. \\ \text{Grape-sugar} & = & \text{alcohol} & + & \text{carbonic-acid gas.} \end{array}$$

Thus it is that the spirits of various foreign wines, beer, and such household wines as orange wine, ginger wine, gooseberry wine, and many others, are obtained, simply by the fermentation of a saccharine solution.

In *bread making* the starch contained in flour is converted into dextrine, and then into sugar, by the yeast which is mixed with flour and water to form dough. Further the sugar is converted gradually into alcohol and

carbonic acid when put into the oven. The heat causes escape of alcohol, and expansion of the bubbles of carbonic acid gas, in every part of the loaf.

Aërated bread is made from flour, by mixing with carbonic-acid gas under pressure. The withdrawal of the pressure, and the application of heat, cause the bread to expand.

Crumb of bread is officinal. Mica panis, B.P.

2. The acetous fermentation yielding acetic acid.
3. The lactic fermentation yielding lactic acid.
4. The mucous fermentation yielding gum and mannite.
5. The butyric fermentation yielding butyric acid. This is an animal ferment, and acts best with oxygen, and in the presence of hydrogen gas.

ORGANIC ANALYSIS.

The ultimate organic analysis of any organic compound is the estimation of the amount of carbon, hydrogen, oxygen, and nitrogen contained therein. The method is as follows (*see* "Attfield's Chemistry," p. 542):—"A weighed quantity of a substance is burnt to carbonic acid gas ($CO_2 = 44$), and water ($H_2O = 18$), and these products collected and weighed; 12 parts in every 44 of carbonic acid gas ($= \frac{3}{11}$) are carbon, 2 in every 18 of water ($= \frac{1}{9}$) are hydrogen; nitrogen, if present, escapes as gas. If nitrogen be a constituent, more of the substance is strongly heated with a mixture of the hydrates of sodium and calcium; these bodies then split up into oxides, oxygen and hydrogen. The oxygen burns the carbon of the substance to carbonic acid gas, its hydrogen and nitrogen appearing as water and ammonia respectively. The carbonic acid and water are disregarded, the ammonia collected and weighed in the form of a double chloride of platinum and ammonium, of which 28 parts in every 447 ($= \frac{1}{16}$) are nitrogen. The difference between the sum of the weights of hydrogen and carbon and the weight of the substance taken is the proportion of oxygen in the body, supposing nitrogen to be absent. If nitrogen is present, the difference between the sum of the percentages of carbon, hydrogen and nitrogen and 100, is the percentage of oxygen. Shortly, carbon is estimated in the form of CO_2 gas, hydrogen as H_2O, nitrogen as ammonia, and oxygen by loss."

ORGANIC MATERIA MEDICA.

This department includes numerous plants and a few animals. The plants spoken of are of all varieties—trees, shrubs, mosses, &c.—and of all parts of the plants, including roots, underground stems, leaves, flowers, fruits, and seeds. For the better understanding of these terms, we shall here devote a few pages to

BOTANY.

THE TISSUES AND CHEMICAL COMPOSITION OF PLANTS.

1. Cellular tissues are composed of simple vegetable cells that resemble each other in all except the shape of their outline. Sometimes the cell is ovoid, stellate, brick-shaped, fusiform, &c. According as they vary in outline so will there exist between the cells differently-shaped channels capable of storing or transmitting fluids. The named parts of the cell are: The *cell wall*, the *protoplasmic contents*, and the *nucleus and nucleolus*. Clear spaces, termed *vacuoles*, appear in the protoplasm in certain conditions, and these are used for storing secretions peculiar to the plant. Cellular tissue is sometimes termed *parenchyma*.

2. Fibro-cellular tissue. When, by a secondary deposit, a *spiral* fibre is laid down inside the cell-wall, the tissue is said to be fibro-cellular. Instead of being laid down in a spiral, the secondary deposit may be laid down as *rings*, or as a *mass* having minute dots or pits. The tissue is accordingly spoken of as *annular* or *pitted*.

3. Vascular tissue comprehends both the woody and fibro-vascular tissues. *a*. Woody tissue consists of cells or tubes placed side by side, and firmly adherent. The tubes are long, fusiform, and tough. Woody tissue is found in the *wood*, the *inner layer of the bark*, and in the so-called *veins of leaves*. A variety of woody tissue in coniferous plants—also met with in strata of coal—is termed glandular tissue. It consists of saucer-like depressions on the surface of a fibre, with circular orifices in their centre. *b*. Fibro-vascular tissue consists of tubes with a spiral or annular fibre coiled inside the outer wall. The cells in which this condition exists are supposed to coalesce and form a tube of fluids, allowing a passage from one part to another. It is chiefly found in the *medullary sheath* and the *veins of leaves*, and these tissues are continuous.

4. Laticiferous vessels are vessels which are found for the most part in the *middle layer of the bark*. They there branch and join each other, forming a fine meshwork. The fluid contained within them is termed *latex*, and the current is supposed to be downwards.

5. Epidermis, the external covering of all parts in young plants, consists of compressed cells lying closely together. *Stomata* are openings between two cells that allow a communication between the intercellular passages and the external air; they are found on the green parts of plants only. Their function is to allow transpiration, regulating both the fluid and gaseous elements in plants.

6. Appendages of many kinds exist; such as, *hairs*, *prickles*, *glandular hairs*, &c.

7. Chlorophyll corpuscles and chromule: *a*. The green colouring matter of plants, called chlorophyll, exists in combination with protoplasm, and imbues every part of the green-coloured parts of plants. Alcohol or ether takes up the colouring matter, and leaves the protoplasm mass otherwise unchanged. The corpuscles at times exhibit peculiar movements, giving rise to *rotation* or *gyration*, as seen with the help of the microscope in the leaf of the American pondweed, or Vallisneria. *b*. Chromule is the name given to the colouring material of the flower, chiefly met with in the corolla. It is in solution in the fluid, and not contained in corpuscles.

8. Contained in plants many salts exist, and many formed bodies:—

(1.) Starch (*see article* Starch).
(2.) Gluten (*see* ditto).
(3.) Albumen (*see* Seeds).
(4.) Raphides are bundles of crystals composed of vegetable acids, combined with lime, to form needle-shaped crystals, as in squills; or stellate masses of crystals, as in rhubarb.
(5.) Sugar (*see* Cane Sugar).
(6.) Soda, in plants growing near the sea.
(7.) Potash, in plants growing inland.
(8.) Phosphates exist mostly in the seeds of cereals, and there it is combined with lime.
(9.) Oxalates occur as oxalate of lime in rhubarb.
(10.) Silica occurs chiefly in grasses.
(11.) Iodine, in marine plants.
(12.) Lime is one of the most abundant of chemical elements, and is found combined with phosphorus, oxalic acid, silicon, sulphur, and as carbonates.

The Root.

In the embryo, whilst it is contained within the seed, the following parts can be made out :—*a*. The plumule, or terminal bud, which grows upwards to form the stem. *b*. The *radicle*, which grows downwards to form the root. *c*. *Cotyledons*, which are two in number in dicotyledons, one in monocotyledons, and absent in some constituting a class called acotyledons. The root consists of fibro-vascular bundles, surrounded by cellular tissue, and covered over by an epidermal layer or epiblema.

I. In acotyledons, radicles are developed all over the embryo or spore.

II. In monocotyledons, the radicle is never developed, and the roots are called adventitious. From beneath the rind of the stem, at the spot where it touches the ground, a multitude of little papillæ of cellular tissue project. These papillæ have pushed their way through the rind, carrying a cap of the hard rind upon them, called the *pileorhiza;* this affords protection to the soft parts as they push their way into the ground. *Fibro-vascular bundles*, similar to those in the stem, find their way into the root.

III. In dicotyledons, the root is developed from the radicle, and constitutes an *axial*, or *true* root. At first cellular, it soon becomes fibrous, by fibro-vascular bundles, similar to those in the stem, appearing in it. The extremity, or tip of each root or rootlet, is older than the part immediately behind it, and termed the *spongiole*. Some consider this organ as having merely a protective function, allowing the soft parts behind to absorb nourishment; others believe the power of absorbing nourishment resides in the organ itself. At the junction of the root and stem the fibro-vascular bundles are heaped together, and thereby end the pith, medullary sheath, cambium, and liber.

Dicotyledons grow by a bifurcation of their growing point; in monocotyledons, the roots increase by producing new adventitious roots.

Functions of the Root.

1. To fix the plant.
2. To absorb nourishment, which must be in a fluid state.
3. To excrete useless or deleterious products.

4. To spread towards material fit to nourish the plant.
5. To store substances, giving the nutritive, medicinal, or poisonous properties peculiar to the plant.

Underground Stems.

1. Rhizomes or rootstocks are thick stems running underground, with roots growing from the under side and leaf-buds from the upper. The officinal rhizomes are *arnica*, *valerian*, and *ginger*.
2. Tubers consist of a thickened portion of an underground stem, having leaf buds in the form of eyes, as in potatoes, each one capable of producing a stalk. The tuber is used by the plant as a store for starch, &c. The officinal tuber is *jalap*.
3. Bulbs are leaf buds remaining permanently in the form of a scale, growing from a flat disc, which from its lower part produces roots. The most familiar example is an onion. The officinal bulb is *squill*.
4. Corms have also leaf buds, but instead of remaining scaly, become a hard solid mass, with roots growing from underneath, as in the crocus. The officinal corm is *colchicum*. Rhizomes and tubers are met with amongst exogens, bulbs and corms amongst endogens.

The Stem.

The simplest form of stem is one consisting of a central loose cellular tissue, surrounded by a denser material lined externally with epidermis. The cellular tissue consists of cells irregular in shape, leaving open meshes capable of transmitting or storing fluids. Amongst these tissues, tubes with spiral linings and fibro-vascular bundles are to be found in all except those of the most rudimentary type. The dense tissue surrounding the soft central portion consists of cells and fibro-vascular bundles firmly grown together. The epidermis may be simple, or prolonged into fine hairs.

Exogenous Stems.

An exogenous stem is developed in plants produced from seeds having two cotyledons—*i.e.*, dicotyledons. The stems of most of our forest trees belong to this class. There is:—

1. The central pith or medulla. This consists of cellular tissue, which in young plants is green and succu-

lent; but after the first year it ceases to grow, and becomes dry and white.

2. The medullary sheath. This is a layer of open vessels with spiral linings, surrounding the pith in a circle. The vessels conduct fluids from the lower part of the stem to the leaves.

3. The wood consisting of bundles of fibro-vascular tissue, and tissues which have become filled up with deposits, constituting woody tissue. A transervse section shows the concentric rings marking the produce of a single year's growth. The youngest part of the stem is external, and the old, hard, central portion is sometimes called the *duramen*, to distinguish it from the softer and younger portions externally called the alburnum or sap wood.

4. The cambium is situate between the wood and the bark. The cells composing the layer are the active elements in producing the wood internally and the bark externally. In spring it is, from the excess of sap, soft and mucilaginous.

5. The bark consists of three layers with, in very young plants, an epidermal covering. *a.* The endophloeum, liber or inner layer, is the vascular layer of the bark. Bundles of vessels from this layer are prolonged up into the leaves. It goes by the name of the bast-layer, and is used for textile purposes. *b.* The mesophloeum, or middle layer, consists of cells and intercellular spaces. The cells are thick walled and green in colour. It is in this layer the medullary rays end. Laticiferous vessels, so named from the milky fluid contained in them, occur in this layer; the current in these vessels is said to be downwards. *c.* The epiphloeum, the outer layer, consists of flattened cells without colouring matter in them, frequently containing air and occasionally developed into a thick layer—*e.g.*, in the cork tree. The layer is sometimes called the corky or tuberous layer.

6. Medullary rays are bands of cells which intersect the tissues of the plant running all the way from the central pith right out to the middle layer of the bark. They consist of cells lying in relation to each other as bricks in a wall, and new rays are formed at every year's growth, as marked by the concentric rings, and so promote transmission of fluids from the centre of the stem to every new concentric ring laid down, and to the middle layer of the bark outside.

Endogenous Stem.

When plants are produced from seeds possessing only one seed lobe, they are said to be monocotyledonous, and their stem is endogenous. The best known plants possessing such a stem are the palms and grasses. The central part is soft and cellular, and the hard rind outside affords it protection. The central part consists of cellular tissue, and in it are found the vessels passing from leaves to root. The hard part externally is not bark, it is simply an aggregation of the vascular fibres of the stem. The fibres from the leaves pass first to the centre of the stem, from whence they diverge, cross the fibres immediately below them, and become the most external—*i.e.*, next the rind. Endogens do not increase in diameter beyond a certain definite period.

Functions of the Stem.

1. To support the organs of nutrition and reproduction, carrying them up to a height sufficient to obtain light and air.

2. To convey fluids from the ground, through the roots, to the flowers and leaves. In young plants all parts convey fluids, but in a well-grown plant, special parts are set aside for the purpose—viz., the vessels of the medullary sheath and the inner layers of the bark. In the middle layer of the bark the vessels there met with and termed laticiferous vessels, are supposed to convey fluids down from the leaves; all the other vessels in the stem conduct fluids upwards.

3. To store secretions. Cellular tissue, or parenchyma as it is called, and the young woody tissues, conduct fluids in young plants; but as these become older and more highly developed they become filled with secondary deposits and useless as conductors of nutrition. The old wood is called the duramen, the young sap wood the alburnum.

Leaves.

The named parts of a leaf are: 1, the blade or lamina; 2, the stalk or petiole; 3, the sheath or vagina, occasionally developed into stipules.

1. The Lamina. The framework or skeleton of the leaf is made up of fibro-vascular tissue prolonged up, through the petiole, from the stem. The main continua-

tion is called the midrib, and from it veins are given off from either side. Those given off directly from the mid-rib are termed primary, and the veins arising from the primary are called secondary. This is the condition in dicotyledonous plants, but in monocotyledonous plants there is no mid-rib, but a number of veins running parallel to each other, and the leaf is said to be parallel-veined. The vascular tissue of leaves communicates with both the spiral vessels of the medullary sheath, and the laticiferous vessels of the bark. Over the framework of the leaf, cellular tissue or parenchyma is extended. On the upper surface the cells are firmly packed in the superficial layers, getting looser towards the lower part and having intercellular spaces. The upper surface cells are arranged perpendicularly to the surface, the under horizontally. Over all is spread the epidermis. The channels in leaves contained within the vascular tissue communicate with the intercellular spaces, and through them by stomata with the external air.

2. The petiole consists of a central cord of vascular tissue, with parenchyma and epidermis covering it. It is occasionally modified to form tendrils, phyllodes, &c. *Tendrils* are fine thread-like projections projected from the mid-rib of the leaf, or from a modified petiole or leaf; they are the means by which the common pea clings to and ascends the sticks supporting it. A *phyllode* is a leaf-like condition of the petiole developed when the lamina is abortive. *Stipules* are lateral expansions at the roots of the petiole, taking many forms; sometimes they look like leaves, sometimes they are developed into *spines*, or they become at times developed into tendrils.

3. The vagina is simply the slight expansion at the spot where the petiole joins the stem. It is at this spot where the leaf usually falls.

Leaves are of two kinds, *simple* and *compound*. The *simple* are undivided leaves; the *compound* are divided down to the mid-rib, so that the subdivisions appear as distinct leaflets. The simple leaves may be in shape linear, ovate, cordate, sagittate, &c.; and in outline serrate, dentate, ciliate, &c. Compound leaves are digitate, pinnate, bipinnate, &c., in their arrangement on the petiole.

The spot from which a leaf develops is called a node, and the interval between two *nodes* is called an *internode*. When at each node a leaf is produced, the leaves are said to *alternate;* when an internode is suppressed, the leaves

are said to be *opposite;* and when a number of internodes are suppressed, and a number of leaves arise together, the leaves are said to be arranged in a *whorl.* Leaves and nodes occur in a regular definite form upon any given plant: thus in the alternate arrangement of leaves, a string passed round the stem, from which the leaves arise, will be seen to ascend in a spiral fashion, and this is considered the typical arrangement. The third leaf will, in some, be found to be immediately above the first, and in others it may be the fifth or sixth. When the third is over the first the string will have made one turn round the stem, and it will be seen that two leaves have been passed on the way—namely, the first and second. Take the one turn as the numerator, and the number of leaves passed as the denominator, and we have a fraction $\frac{1}{2}$. This plan, modified according to the different varieties, is a means of expressing shortly the position of leaves on a stem.

Functions of the Leaf.

1. The exhalation of fluids. This takes place by stomata, and wherever a thin epidermis obtains. Where few stomata exist, and where the epidermis is thick, the exhalation of the leaf is but little, and the leaf becomes thick, succulent. Light is the great promoter, for the brighter the light the greater the exhalation.

2. The absorption of fluids. This takes place by the same channels as the former. When absorbed in too great quantity, fluids pass into the spiral vessels, displace the air therein contained, and thereby disturbing the nutrition of the plant, check or stop the growth.

3. The absorption of gases. Plants absorb carbonic acid gas from the air, break up the gas into carbon, which they retain and incorporate in their substance, and give off the oxygen.

4. The exhalation of gases. Oxygen is given off from plants in a free state. Although the process of breaking up carbonic acid gas into carbon and oxygen is believed in by most botanists, still many hold the reverse opinion, and affirm that oxygen from the air is necessary for the chemical changes essential to the formation and existence of plants.

5. The elaboration of the sap of the plant, towards which it is conducted by the spiral vessels of the stem.

6. The formation of peculiar secretions.

Inflorescence.

The arrangement of flowers on the flower stalk is called the inflorescence. The rachis is the stalk supporting the group of flowers, and the peduncle is the stalk supporting each flower. When a flower-bud is situated at the top of the stem, the stem may go on growing until the bud expands, but when it does, the growth of the stem is stopped in that direction. This is said to be *definite* inflorescence. When a leaf-bud terminates the stem, it can go on growing indefinitely; this form of inflorescence is called the *indefinite.* When definite inflorescence prevails the terminal bud is developed first, and were one to look down on the top of such a plant when the flowers are opening, one would see the central flower, or that on the end of the stem, opening first, and all the others lower down would open afterwards, those nearer the top always opening before those lower down. Suppose the plant had a flat top, like a daisy, then the central floret would expand first, and the others would open gradually, spreading from the centre; this plan of opening is called *centrifugal.* On the other hand, were the outer florets to open first, the mode of the procedure of opening would be from the margin towards the centre or *centripetal.*

1. Definite inflorescence.

a. The cyme is the general name given to the arrangement of flowers developing in a centrifugal manner. It is characteristic of the definite inflorescence. There are two chief varieties, the uniparous and the biparous. The uniparous cyme has its secondary buds developed only on one side of the axis, as in hyoscyamus; the biparous cyme has, as in most of the chickweed family—Caryophyllaceæ—the flowers developed on both sides of the stalk.

2. Indefinite inflorescence.

a. The raceme. When a stalk or rachis has its secondary stalks or peduncles supporting flowers equal in length, it is called a raceme, as in the currant.

b. The corymb. Should the lower flower stalks elongate so as to bring the florets to a level, as in the cauliflower, it is called a corymb.

c. The umbel. In this instance, imagine the internodes of the raceme or corymb to be suppressed, bringing the flower stalks to arise from the same point, as in the plants belonging to the Umbelliferæ.

d. The capitulum. Instead of the axis being prolonged

to a point it may be flattened out to form a top or capitulum, and on this the florets are placed. In the daisy there are two kinds of florets. Those near the centre are called florets of the disc, those at the circumference florets of the ray. (*See* Compositæ.)

The Flower.

The bud that develops a flower is called a flower bud, and the stem ceases to grow further in that direction. The stalk that supports a flower is called the rachis, and this, at the top, where the flower is implanted, expands to form a conical or flattened part, named the receptacle, torus, or thalamus. The leaf, from the axil of which a flower is developed, is named *a bract;* and this has an important bearing in the arrangement of the whorls of the flower. The different whorls of the flower are inserted into the receptacle; and in a typical plant the different whorls have each a separate insertion, being from within inwards in a flattened receptacle, or from below upwards in a conical one—calyx, corolla, stamens, and pistils. According as these whorls are inserted into the receptacle, so dicotyledonous plants are classified into the great systems—Thalamifloræ, Calycifloræ, Corollifloræ, and Monochlamydeæ.

1. Thalamifloræ have calyx, corolla, and stamens, with separate insertions into the receptacle. The stamens, being inserted below the level of the ovary, are said to be hypogynous.

2. Calycifloræ. In this group the calyx, corolla, and stamens unite to form a calyx-tube, enclosing the ovary. The stamens in this group of plants are either around the ovary (perigynous), or projecting beyond, or upon it (epigynous).

3. Corollifloræ. The calyx has a separate insertion into the receptacle, but the corolla and stamens are inserted together. The corolla, being gamopetalous, presents a sort of corolla-tube.

4. Monochlamydeæ. To this group are referred plants having flowers the outer whorls of which are green; the corolla is supposed to be absent.

The flower in monocotyledonous plants is also the chief means of classifying the plants belonging thereto:—

a. Spadicifloræ. The axis is prolonged into a spadix—*i.e.*, a thick fleshy process, on which the ovules are developed; and the perianth—*i.e.*, the conjoined calyx and corolla—forms a spathe, or enclosing sheath.

b. Petaloideæ. The perianth is in this class double, both whorls being alike either sepaloid or petaloid—*i.e.*, either green or coloured.

c. Glumifloræ. In this group the named parts are, from within outwards—ovary, stamens, lodiculæ, paleæ, and glumes (*see* Graminaceæ).

The flowers belonging to dicotyledonous plants have as a typical number five in each whorl; those belonging to monocotyledonous plants have three. In dicotyledons the sepals and petals are arranged in a definite manner, and are so placed that one sepal and petal of the five is within the edge of the others, and one sepal and petal is wholly without and separate. To understand this aright, hold the bract towards oneself; it is said then to be anterior. Look now for the odd sepal—that is, the one without the edges of the others—and it will be found to be on the side of the flower opposite the bract, or posterior. The odd corolla will be found to be in the reverse situation—namely, anterior, or in the side of the flower adjacent to the bract. The calyx and corolla are together spoken of as the perianth. This arrangement is the general one in dicotyledons; but, in a well-marked group—namely, the plants belonging to Leguminosæ—the opposite condition obtains, the odd sepal being anterior, the odd petal, posterior.

The stamens, instead of being five, are usually ten or more in number, and it is impossible to arrange them into anterior and posterior positions as in the other groups. Pistils are frequently reduced to one, two, or three, or, may be, multiplied indefinitely.

The Calyx.

The outermost whorl of the flower is composed of separate pieces, called sepals. When these are all distinct one from the other, they are said to be *polysepalous;* when the edges unite and form a continuous whorl, the calyx is said to be *gamosepalous* or monosepalous. The calyx is much modified in regard to colour, and in regard to its relation to the rest of the plant. When the calyx is adherent to the ovary covering it over, it is called adherent or superior; when, on the other hand, the calyx is attached below the level of the ovary, it is said to be non-adherent or inferior.

The terms superior and inferior are often used when speaking of the fruit.

The Corolla.

The showy and coloured part of the flower is composed of individual pieces called petals. The terms polypetalous and gamo- or mono-petalous are used, as with the calyx, to signify different arrangements as to union of the petals. According to the semblance the corolla presents to known shapes, so it is called campanulate, or bell-shaped; infundibuliform, or funnel-shaped; tubular, rotate, or wheel-shaped; urceolate, or urn-shaped. Various irregular forms occur that are more difficult to understand. Thus, the labiate or lipped corolla, as in Labiatæ; the ligulate, or strap-shaped corolla, when all the parts of the corolla are united together on one side of the flower, as in the florets of the dandelion. The most difficult to understand is the papilionaceous corolla, where the five petals are arranged in a form peculiar to the pea tribe. The large, flattened piece is called the vexillum or standard; the two lateral are called the alæ or wings; and the two central are united together to form the carina or keel (*see* Leguminosæ).

The Stamen,

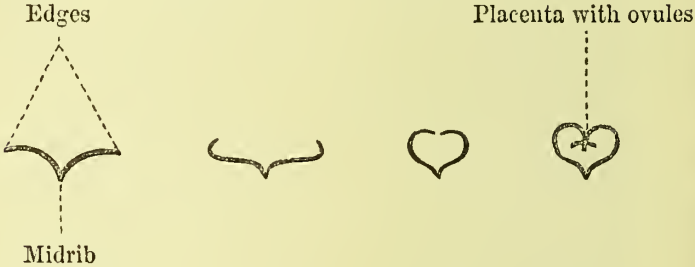
or male organ of the plants, consists of two parts—the *anther* and *filament*. The filament is the stalk on which the anther is supported, and contains vascular tissues, carrying nourishment to the anther. The anther, within which is prepared the pollen, consists of two halves or lobes, between which is placed the septum, or connective. *Pollen* consists of a number of grains or vesicles, and each vesicle contains within it a semi-fluid substance, called fovilla. The function of the pollen is to impregnate the ovule; and when, by dehiscence or splitting, the anther allows the pollen to escape, the particles are scattered around the pistil, and cling to it. When the anther is absent, the stamen is abortive. Different degrees of union exist in this whorl, as in the others. When the filaments unite to form one bundle or whorl around the pistil, they are said to be monadelphous; when, in two bundles, diadelphous, as in the pea family. When the anthers unite they are said to be *syngenesious*.

The Pistil.

The central and female part of the plant consists of individual parts or carpels adherent together, and constituting *the ovary*. When only one carpel is present, the pistil is said to be simple; when more than one, compound. The pistil consists of the ovary, containing the

ovules or buds, the style, and on the top of the style the stigma. Each carpel of which the pistil is composed, is a modified leaf, and the parts and relations are explained thus: the edges of the leaf bend towards each other and, finally meeting, turn in towards the cavity enclosed in the form of a ridge

Fig. 16.—Diagram of Sections of a Leaf, showing Formation of Placenta.



The inturned edge is named the *placenta*, and from the placenta the ovules or buds are produced. The placenta is said to be parietal when it is placed on the inturned edges; but, when it leaves the edges, and stands up in the centre, it is said to be central or axile. In a compound pistil, the individual carpels are placed side by side, and firmly adhere; between the cavities or loculi, formed by each carpel, septa remain, so that in any fruit, say an orange, the number of carpels from which it is formed may be counted. Take a transverse section of an orange. The white partitions are the adherent edges of the carpels forming it; and the seeds are in the centre, growing from the placenta, which, in this case, is parietal. The part representing the mid-rib of the leaf or carpel would be towards the rind, and opposite the middle of each loculus. It is at this spot that dehiscence generally occurs, allowing the escape of the seeds.

The style is simply a prolongation of the carpel; it is a non-essential part of the pistil, and is frequently absent.

The stigma is usually placed on the top of the style. It is peculiar as being the only part of the plant destitute of epidermis, and from it a viscid fluid is secreted, which causes pollen to adhere.

The ovules or seed-buds, growing from the placenta, are at first small vesicular bodies, which by-and-by come to consist of a nucleus and its coverings, connected at the

base by a funiculus or cord. At the opposite end is a small opening or foramen, in the coverings, termed the micropyle.

The position of the ovules in the ovary gives rise to the terms erect, ascending, inverted, and suspended, according as the ovule is at the bottom, sides, or top of the ovary.

Fertilization occurs when the fovilla from the pollen clings to the stigma, sends prolongations down through the style to the ovary, and finds its way through the micropyle into the nucleus of the ovule. Ovules now become seeds, and the seeds with their coverings constitute the fruit.

The Seed.

The impregnated and matured ovules constitute the seeds. When the seeds are enclosed in the ovary or seed vessel, as in most plants, they are termed angeiospermous; when the seed is uncovered as in pines and conifers, they are said to be gymnospermous. The parts of a seed are the coverings and the contents.

The coverings are two in number—an external, the *testa;* and an internal, the *tegmen.* Contained in most seeds is the *albumen,* a substance consisting of starchy matters, oil, and nitrogenous compounds. The *embryo* lies buried in this substance; it consists of *radicle, plumule,* and *cotyledons;* in fact, all the parts of the plants are here shadowed forth in a rudimentary state. The plumule grows up, seeking light and air, and develops into the stem; the radicle grows down to form the root and absorb nourishment; cotyledons, or seed-leaves, protect the tender parts when they first come in contact with the earth. Plants are a-, mono-, di-, or poly-cotyledonous, according as there are no cotyledons or one, two, or many cotyledons.

The Fruit.

The ovary when matured, with its contents and coverings, constitutes the fruit. The parts of a fruit are to be made out in a cherry or peach. The skin is the *epicarp,* the pulp the *mesocarp,* and the stone is the *endocarp* having the seed within. The whole of these taken together constitute the *pericarp.*

Fruits are spoken of as superior or inferior, according to their relation to the calyx. When the calyx is adherent and covers over the fruit, the fruit is said to be *inferior*, as in the apple, the skin of the apple being formed by the calyx; when, on the other hand, the calyx is non-adherent and below the level of the ovary, the fruit is said to be *superior*. Before the seeds can escape the fruit must either dehisce or waste away, when the fruit has fallen to the ground. *Indehiscent* and *dehiscent* are the names used to express these different properties. When dehiscence occurs the carpels constituting the fruit may part at the septa or opposite the loculi. Thus, in an orange, were the septa to give way, the fruit would be said to dehisce in a *septicidal* manner; but if opposite the loculi, that is, between two septa, it would be called *loculicidal* dehiscence. So, as modifications, we have *porous* dehiscence as in the poppy, where a few small holes or pores on the top of the fruit allow the seeds to escape. Sometimes the sides of the pericarp give way in a valve-like fashion, constituting *valvular* dehiscence.

Apocarpous fruits are those formed out of one or more free carpels.

Syncarpous fruits are formed when several carpels are united.

Of the many different kinds of fruits only the important are here given.

A. *Indehiscent Fruits.*

I. With one seed.
   1. With dry pericarp.
      a. Achene; the little yellow bodies scattered over the red surface of the strawberry are achenes. The red surface is the receptacle much expanded.
      b. Caryopsis, as in wheat.
      c. Utricle, as in chenopodium.
      d. Glans, or nut, as in the acorn, hazel-nut, or chestnut. The cup of the acorn is formed by bracts; and the pericarp is hard, forming the shell.
      e. Samara, a winged fruit, as found in quantity below an elm tree in autumn.

2. With pulpy pericarp.
   a. Drupe, *ex.*, a cherry (*see* p. 213).
   b. Etærio, an aggregation of drupes, as met with in the raspberry.

II. With more than one seed.
   a. Berry, as in the gooseberry.
   b. Hesperidium, as in the orange. The rind is formed of the epicarp and the mesocarp.
   c. Pomum, as in the apple, where the calyx is superior—*i.e.*, covers over the ovary as the epicarp, and with the mesocarp forms the fleshy edible mass. The horny substance immediately around the seeds is the endocarp.

B. *Dehiscent Fruits.*

I. Apocarpous.
   a. Legume, as in the pea-pod, which consists of a single carpal dehiscing by both the dorsal suture—*i.e.*, the mid-rib of the leaf, and the ventral suture—*i.e.*, where the edges of the carpal meet to form the placenta.
   b. Follicle, as in chenopodium, dehiscing by only one suture.

II. Syncarpous.
   a. Capsule, as in the poppy, where it dehisces by pores; or in the foxglove, where dehiscence takes place by valves.
   b. Siliqua, a flattened fruit, opening by a valve on either side, and leaving a septum termed a replum, which supports the seeds between the valves. Met with in the wallflower.

III. Anthocarpous—*i.e.*, when the bracts and whorls of the flower are united together to form the fruit.
   a. Sorosis, as in the pine-apple.
   b. Syconus, as in the fig, where a hollow fleshy edible receptacle receives numerous achenes.

LIST OF OFFICINAL VEGETABLE SECRETIONS.

Juices.

SECRETIONS.	FROM
1. Elaterium	Ecbalium officinarum
2. Kino	Pterocarpus marsupium.
3. Limonis succus	Citrus limonum.
4. Manna	Fraxinus ornus.
5. Opium	Papaver somniferum.
6. Saccharum	Saccharum officinarum.

Gums.

1. Acacia	Undetermined acacia.
2. Tragacantha	Astragalus verus.

Gum Resins.

1. Ammoniacum	Dorema ammoniacum.
2. Assafœtida	Narthex assafœtida.
3. Elemi	Canarium commune.
4. Galbanum	Galbanum officinale.
5. Gambogia	Garcinia morella.
6. Myrrha	Balsamodendrum myrrhæ.
7. Scammonium	Convolvulus scammonia.

Resins and Oleo-Resins.

1. Copaiba	Copaifera multijuga.
2. Guaiacum	Guaiacum officinale.
3. Mastiche	Pistacia lentiscus.
4. Podophylli resina	Podophyllum peltatum.
5. Pix burgundica	Abies excelsa.
6. Resina scammonia	Convolvulus scammonia.
7. ,, jalapae	Exogonium purga.
8. Resina	Residue after distilling oil of turpentine from various pines.
9. Terebinthina canadensis	Abies balsamea.
10. Thus americanum	Abies excelsa.

Balsams.

Balsamum peruvianum	Myroxylon Pareira.
Balsamum tolutanum	,, toluiferum.
Benzoinum	Styrax benzoin.
Styrax	Liquidambar orientale.

Fixed Oils.

SECRETIONS.	FROM
1. Amygdalæ oleum . .	Amygdalus communis.
2. Crotonis oleum . . .	Croton tigilium.
3. Lini oleum	Linum usitatissimum.
4. Myrsticæ oleum . .	Myristica officinalis.
5. Olivæ oleum	Olea europea.

Volatile Oils.

1. Anethi oleum . . .	Anethum graveolens (dill).
2. Anthemidis oleum . .	Anthemis nobilis.
3. Anisi oleum	Pimpinella anisum.
4. Cajuputi oleum . . .	Melaleuca minor.
5. Caryophilli oleum . .	Caryophyllus aromaticus.
6. Camphora	Camphora officinarum.
7. Carui oleum	Carum carui.
8. Cinnamomi oleum . .	Cinnamomum zeylanicum.
9. Copaibæ oleum . . .	Copaifera multijuga.
10. Coriandri oleum . .	Coriandrum sativa.
11. Cubebæ oleum . . .	Cubeba officinarum.
12. Juniperi oleum . . .	Juniperis communis.
13. Lavandulæ oleum . .	Lavandula vera.
14. Limonis oleum . . .	Citrus limonis.
15. Menthæ piperitæ oleum	Mentha piperita.
16. Menthæ viridis oleum	Mentha viridis.
17. Myristicæ oleum . .	Myristica officinalis.
18. Pimentæ oleum . . .	Eugenia pimenta.
19. Rosmarini oleum . .	Rosmarinus officinalis.
20. Rutæ oleum	Ruta graveolens.
21. Sabinæ oleum . . .	Juniperis communis.
22. Terebinthinæ oleum .	Pinus palustris.

Alkaloids and Salts of Alkaloids.

1. Aconitia	Aconitum napellus.
2. Atropia	Atropa belladonna.
3. Beberiæ sulphas . .	Nectandra Rodiæi.
4. Morphia	Opium (papaver somniferum).
5. Quiniæ sulphas . .	Cinchona flava.
6. Strychnia	Strychnus (nux vomica).
7. Veratria	Asagræa officinalis (cevadilla).

Natural Principles.

1. Digitalinum	Digitalis purpurea.
2. Santoninum	Artemisia santonica.

VEGETABLE KINGDOM.

PHANEROGAMIA—*i.e.*, FLOWERING PLANTS.

Class I.—Exogenæ.

Sub-Class I.—Thalamifloræ.

NATURAL ORDER—RANUNCULACEÆ. 5. 5. ∞ ∞.

Five sepals, five petals, stamens indefinite, pistils indefinite; all the whorls are distinct one from the other; and the petals and sepals are polypetalous and polysepalous. The plants are mostly herbs with watery, acrid juice. Stems, slender, round and hairy or smooth. Leaves exstipulate. Fruit, achenes, follicles, or berries. Seeds, albuminous. Habitat, cold and temperate climates.

Properties.—Acrid. A few plants of the order are poisonous, as aconitum napellus, aconitum ferox, and various species of clematis and ranunculus. The more common non-officinal plants are ranunculus repens, aquatilis, acris; cultha palustris—the marsh marigold; pæonia officinalis; helleborus niger, hellebore, delphinium staphisagria.

I. Aconitum napellus (monkshood).—*Parts used:*

1. Aconiti folia, leaves of flowers dried. The leaves are wedge-shaped, with deeply cut segments. Flowers are blue and helmet shaped.
   - *a.* Extractum aconiti. *D.* 1–2 grs. Made as other green extracts.
2. Aconiti radix. Apt to be mistaken for a horse-radish root, from which it is distinguished by being shorter, thinner, not cylindrical, and giving rise to tingling and numbing when chewed.
   - *a.* Tinctura aconiti. *D.* 5–15 mins. Aconite root, $2\frac{1}{2}$ oz.; rectified spirit, 20 oz.
   - *b.* Linimentum aconiti. Aconite root, 20 oz.; camphor, 1 oz.; rectified spirit, a sufficiency.
3. Aconita (*see* Alkaloids).
   - *a.* Unguentum aconitiæ (8 grs. in 1 oz.) Aconitia, 8 grs.; rectified spirit, $\frac{1}{2}$ dr.; prepared lard, 1 oz.

   Used in febrile conditions to reduce temperature, to slow the heart, to increase

the quantity of urine and sweat. It is applied externally for neuralgia and rheumatic pains.

II. Podophyllum peltatum (the Mayapple).—*Part used:*

1. Podophylli radix. The rhizome. *D.* 10–20 grs.

Composition.—Resin, berberine, gum, &c.

(i.) Podophylli resina. *D.* $\frac{1}{4}$–2 grs. A greenish-brown amorphous powder.

Used as a purgative and cholagogue in liver congestion and in dropsy.

MENISPERMACEÆ.

I. Jateorrhiza calumba.—*Part used:*

Calumbæ radix. *D.* 10–20 grs. Consists of the root cut transversely and dried, when it occurs as yellow ovoid discs, hollow in the centre and with concentric rings.

Composition.—Calumba, berberin, starch, &c.; no tannin.

Preparations:

a. Tinctura calumbæ. *D.* $\frac{1}{2}$–2 drs.
b. Extractum calumbæ. *D.* 2–10 grs.
c. Infusum calumbæ. *D.* 1–2 oz.
Made with cold water.

Used as a bitter and stomachic tonic in dyspepsia and debility. The infusion may be given with iron salts, because being made with cold water it contains no tannin.

II. Cissampelos Pareira.—*Part used:*

1. Pareiræ radix. The root is dark grey in colour and distinguished by the eccentric woody rings seen in section. Active principle is the alkaloid cissampelin.

a. Decoctum Pareiræ. *D.* 1–2 oz.
b. Extractum Pareiræ. *D.* 10–20 grs.
c. Extractum Pareiræ liquidum. *D.* $\frac{1}{2}$–2 drs.

Used as a diuretic and sedative in catarrh of the urinary tract.

PAPAVERACEÆ. 2. 4. ∞. $\widehat{\infty}$.

Two sepals, four petals, stamens indefinite, pistils indefinite and adherent one to the other. The plants of this order are all herbs, possessing in the stems, leaves, and fruits a milky juice. Stems are round, hairy, and slender. Leaves, without stipules. The sepals are caducous—*i.e.*, they fall early, and in the poppy they fall after the expansion of the flower. Petals brightly coloured, generally scarlet. Ovary one-celled, placentæ parietal—*i.e.*, attached to the wall of the ovary. Fruit, a capsule ; seeds, indefinite and albuminous. Habitat, mostly European.

NON-OFFICINAL PLANTS are—

Papaver dubium . . .	The long-headed poppy.
Papaver hybridum . .	The rough poppy.
Papaver argemone . .	The pale poppy.
Meconopsis cambrica .	The Welsh poppy.
Chelidonium majus . .	Common celandine.
Glaucium luteum . . .	The yellow, horned, or sea poppy.

OFFICINAL PLANTS are—

I. PAPAVER RHŒAS—the Field Poppy.

Parts used.—1. Rhœados pet ala—the petals dried.

Composition.—Rhœadine and red colouring matter.

a. Syrupus rhœados. *D.* 1 dr.

Used as slight sedative for children, also as a colouring agent.

II. PAPAVER SOMNIFERUM—the Garden Poppy.

Parts used.—1. Papaveris capsulæ—the nearly ripe capsules dried and deprived of their seeds.

a. Decoctum papaveris—capsules boiled in water.
b. Extractum papaveris. *D.* 2–5 grs.
c. Syrupus papaveris. *D.* 1 dr.

2. Opium (ὀπός, the juice).—After the fall of the petals incisions are made in the unripe capsules. The incisions are made so as not to open the interior of the capsule. After the juice has dried by evaporation, the tears of opium that form are scraped off and collected.

Varieties of opium :—

Turkey opium is of two varieties :—*Constantinople opium*, marked by the mid-rib of the leaf, in which it is developed, and *Smyrna opium*, which is covered with a chaffy substance, and the remains of poppy leaves.

Egyptian opium, occurs as flat cakes.

Indian opium, in large round balls, like 24-pound shot.

The Turkey opium is the only officinal variety, and is the richest in active constituents.

Composition of opium :—

Water	30 per cent.
Resin, mucilage, albumen	60 ,,
Wax, sugar, colouring-matter, salts	10 ,,

THE ACTIVE INGREDIENTS are—

Acids, Alkaloids, and Neutral Bodies.

Acids.—1. Meconic acid, $C_7H_4O_7$, occurs as crystalline pearly-looking scales. Given alone, the acid is inert, but combined with morphia, it no doubt modifies its action. When testing for opium it is the meconate of morphia which yields the reactions.

Alkaloids :

I. Morphia (*see* Alkaloids).
II. Codeia (*see* Alkaloids).
III. Thebaia (*see* Alkaloids).
IV. Narcotine (*see* Alkaloids).

Neutral Bodies :

I. Narcein, a hypnotic.
II. Meconine, a hypnotic.
Apomorphia (*see* Alkaloids).

Preparations :

A. Opium. Solid. *D.* $\frac{1}{6}$–2 grs.

1. Tinctura opii. *D.* 5–40 min. (1 in 14$\frac{1}{2}$). Macerate in spirit (laudanum).
2. Tinctura camphoræ composita. *D.* 15–60 min. (1 gr. in $\frac{1}{2}$ oz.). Opium, benzoic acid, camphor, oil of anise and proof spirit.
3. Tinctura opii ammoniata (paregoric). *D.* 15–60 min. (1 in 96). Opium, strong solution of ammonia, benzoic acid, oil of anise, saffron, and proof spirit.
4. Pilula saponis composita. *D.* 3–5 grs. (1 in 5). Opium, soap, and water.
5. Pilula ipecacuanhæ cum scilla. *D.* 5–10 grs. (1 in 23$\frac{1}{2}$). Compound powder of ipecacuanha, squills, ammoniacum, and treacle.
6. Pilula plumbi cum opio. *D.* 4–8 grs. (1 in 8). Opium, acetate of lead, and confection of roses.
7. Pulvis ipecacuanhæ compositus. *D.* 5–15 grs. (1 in 10). (Dover's powder). Opium, ipecacuanha, and sulphate of potash. The sulphate of potash is added to allow of the better mixing of the powder.

8. Pulvis opii compositus. *D.* 2–5 grs. (1 in 10). Opium, caraway, ginger, pepper, and tragacanth.
9. Pulvis kino compositus. *D.* 5–20 grs. (1 in 20). Opium, kino, and cinnamon.
10. Pulvis cretæ aromaticus cum opio. *D.* 10–40 grs. (1 in 40). Opium and aromatic powder of chalk.
11. Extractum opii. *D.* $\frac{1}{2}$–2 grs. (2 in 1). Evaporate a cold infusion; it is double the strength of ordinary opium.
12. Extractum opii liquidum. *D.* 10–40 mins. (1 in $14\frac{1}{2}$). Dissolve the extract in water, and add spirit. As made officinally, it is one-seventh stronger than the tincture, but more spirit is added to keep it; this brings it to the same strength as the tincture.
13. Vinum opii. *D.* 10–40 mins. (1 in $14\frac{1}{2}$). Extract of opium dissolved in sherry, cloves, and cinnamon bark. (1 in 22.) By adding a little more spirit, it keeps better, and the strength is brought to the same as the tincture.
14. Confectio opii. *D.* 5–20 grs. Compound powder of opium, 192 grs., and syrup, 1 oz.
15. Trochisci opii. *D.* 1–4 ($\frac{1}{10}$ gr. in each).
16. Enema opii. Tincture of opium, mucilage of starch, $\frac{1}{2}$ dr. in 2 oz. It is usual to administer one-half more opium by the rectum than by the mouth.
17. Suppositoria plumbi composita (1 gr. in each). Opium, acetate of lead, benzoated lard, white wax, and oil of theobroma.

The following are used for external application.

18. Linimentum opii. Tincture of opium and liniment of soap, 2 oz. each.
19. Unguentum galli cum opio (1 in $14\frac{1}{2}$). Ointment of galls and opium.
20. Emplastrum opii. Opium one part, resin plaster nine parts.

A few *non-officinal* preparations.

1. Liquor opii sedativus (Battley). *D.* 5–10 mins. About 40 per cent. stronger than the tincture.
2. Nepenthe. *D.* 5–40 mins.
3. Pilula calomelanos et opii. 2 grs. of calomel and $\frac{2}{3}$ grs. of opium.
4. Black drop. *D.* 4–10 mins. Four times the strength of the tincture.

Morphia (*see* Alkaloids), $C_{17}H_{19}NO_3$. It occurs in opium as the meconate of morphia, and is separated during the preparation of the hydrochlorate.

From its insolubility in water, it is not used in medicine. It occurs as a powder usually; but is naturally crystalline, showing bright, colourless, six-sided prisms.

From hence is derived:

I. Morphiæ hydrochloras. *D.* $\frac{1}{6}$–$\frac{1}{2}$ gr. (For preparation, *see* Alkaloids.)

It occurs in white acicular prisms of silky lustre. Soluble in water and spirit.

a. Liquor morphiæ hydrochloratis (4 grs. in 1 oz). *D.* 10–60 mins. Hydrochlorate of morphia dissolved in a solution of hydrochloric acid, rectified spirits and water.

b. Trochisci morphiæ ($\frac{1}{36}$ gr. each.) *D.* 1–4.

c. Trochisci morphiæ et ipecacuanhæ. ($\frac{1}{6}$ gr. in each.) *D.* 1–4.

d. Suppositoria morphiæ ($\frac{1}{2}$ gr. in each).

e. Suppositoria morphiæ cum sapone ($\frac{1}{2}$gr. in each.

II. Morphiæ acetas. *D.* $\frac{1}{8}$–$\frac{1}{2}$ gr.

Preparation. Made from a solution of the hydrochlorate of morphia, by precipitating morphia with ammonia, and neutralizing with acetic acid.

It occurs as a white powder. It is soluble in both spirit and water.

a. Liquor morphiæ acetatis. *D.* 10–60 mins. (4 grs. in 1 oz.) Acetate of morphia dissolved in acetic acid and spirit.

b. Injectio morphiæ hypodermica. *Inj.* 1–6 mins. (1 in 12.) Hydrochlorate of morphia, solution of ammonia, acetic acid and distilled water.

Uses and actions. In small doses, opium, morphia, &c., act as slight stimulants; in fair and large doses a short period of excitement is followed by soporific effects. Sensibility is lessened, pain is less felt, secretion is reduced, and the vermicular motions of the intestines held in abeyance. In sleeplessness, inflammation, pain, cough, dysentery, and diarrhœa, opium is much used.

Externally it is applied to relieve the pain of rheumatic joints, colic, piles, &c..

Cruciferæ. 4. 4. 6. $\widehat{2}$.

Sepals, four, deciduous—*i.e.*, falling off about same time as the corolla. Petals, four, arranged in the form of a cross. Stamens, six, four long and two short, called tetradynamous; the four long stamens are looked upon as two short normal stamens that have split and lengthened.

Ovary, two-celled. Fruit, a siliqua, or silicula—*i.e.*, a syncarpous, dehiscent fruit, consisting of two carpels, with a false septum or replum stretching across between them. When the fruit is long and narrow, it is termed a siliqua, but when short and broad, a silicula.

Habitat.—Temperate climate.

Properties.—Bitter, stimulant, and emetic.

Non-officinal plants are: brassica oleracea—the wild cabbage and many garden vegetables, as cabbage, cauliflowers, broccoli, kale, turnips, &c. Nasturtium officinale—the common water-cress, also penny-cress, bitter-cress, &c. &c.

Officinal Plants.

I. Sinapis nigra $\left.\right\}$ Mustard. *D.* 2 drs.–1 oz.
II. Sinapis alba

a. Cataplasma sinapis. Mustard poultice.

b. Charta sinapis. Powdered seeds attached to paper by a solution of gutta percha.

1. Oleum sinapis. Obtained from the seeds by expression and distillation.

   a. Linimentum sinapis compositum. Oil of mustard, ethereal extract of mezereon, rectified spirit, castor oil, and camphor.

Used as a rubefacient vesicant in deep seat inflammations, and as an emetic in poisoning.

III. Cochlearia armoracia (horse-radish). The part used is the root; it is apt to be mistaken for aconite (*see* Aconite).

1. Armoraciæ radix is used in making—

   a. Spiritus armoraciæ compositus. *D.* 1–2 drs.

Used as a tonic, sudorific, and diuretic in dyspepsia, rheumatism, dropsy, &c.

Polygalaceæ. 5. $\widehat{3}$. $\widehat{8}$. $\widehat{2}$.*—*The Milkwort Family.*

Sepals, five, polysepalous; petals, three, gamopetalous, something like a papilionaceous corolla. Habitat, generally distributed.

Properties.—Bitter and astringent.

I. Polygala senega.—*Part used:*

1. Senegæ radix. The rhizome. *D.* 20–60 grs.

   a. Infusum senegæ. *D.* 1–2 oz.

   b. Tinctura senegæ. *D.* $\frac{1}{2}$–2 oz.

* The brackets above imply union of the individual constituents of a whorl.

Used as a stimulant, expectorant, diaphoretic, and emmenagogue in bronchitis, dropsy, and dysmenorrhœa.

II. Krameria triandra.—*Part used:*

1. Krameriæ radix. *D.* 20–60 grs.
   - *a.* Tinctura krameriæ. *D.* ½–2 drs.
   - *b.* Extractum krameriæ. *D.* 5–20 grs.
   - *c.* Infusum krameriæ. *D.* 1–2 oz.

Used as an astringent in many affections of the alimentary canal, and in leucorrhœa.

Linaceæ. 5. 5. 5. $\widehat{5}$.—*The Flax Family.*

Sepals imbricate—*i.e.*, they overlap; petals, contorted; ovary, many celled, each cell containing a seed. The seed is without albumen, but contains much oil. Habitat, generally distributed.

Properties. — Some plants are demulcent, others purgative.

I. Linum usitatissimum (linseed).—*Parts used:*

1. Lini semina. The seeds.
   - *a.* Infusum lini. *D. ad libitum.*
2. Lini oleum. The oil obtained by expression.
3. Lini farina. The meal.
   - *a.* Cataplasma lini, linseed poultice.

Used as a demulcent in dysentery and bladder affections.

Malvaceæ. $\widehat{5}$. $\widehat{5}$. $\widehat{\infty}$. $\widehat{\infty}$.—*The Mallow Family.*

Sepals five, gamosepalous, valvate; petals, five, gamopetalous, contorted. Stamens, five, monadelphous —*i.e.*, in one bundle. Seeds with little or no albumen. Habitat, chiefly tropical.

Properties.—Demulcent.

I. Gossypium herbaceum. The fine tubular unicellular filaments attached to the seeds are, by carding, made into—

1. Gossypium. Cotton.

   From hence is obtained:

   (i.) Pyroxylin. Gun cotton, made by dipping cotton wool into a mixture of equal parts of nitric and sulphuric acids.

   From hence is obtained:

   - *a.* Collodium: collodion, made by dissolving gun cotton in ether and rectified spirit.

From hence is obtained:

a. Collodium flexile. Flexible collodion. Made by mixing collodion with Canada balsam and castor oil.

Used as a protective to burned surfaces, to stop bleeding, to cracks, and chapped nipples, fingers, &c.

AURANTIACEÆ.—*The Lemon Family.*

I. Citrus bigaradia and C. aurantium.—*Parts used:*

1. Aurantii floris aqua.
   - *a.* Syrupus aurantii floris. *D.* 1 dr.
2. Aurantii fructus (orange fruit).
   - *a.* Vinum aurantii. *D.* 2–4 drs.
     Used in iron and quinine wines.
   - *b.* Tinctura aurantii recentis. *D.* 1–2 drs.
3. Aurantii cortex (bitter orange peel).
   - *a.* Infusum aurantii compositum. *D.* 1–2 oz.
   - *b.* Tinctura aurantii. *D.* ½–2 drs.
   - *c.* Syrupus aurantii. *D.* 1–2 drs.
   - *d.* Infusum aurantii. *D.* 1–2 oz.
     Used as a stomachic tonic in dyspepsia, and to give flavour to mixtures.

II. Citrus limonum.—*Parts used:*

1. Limonis succus (lemon juice). *D.* 1 dr. Expressed from the ripe fruit.
2. Limonis cortex.
   - *a.* Syrupus limonis. *D.* 1 dr.
   - *b.* Tinctura limonis. *D.* 1 dr.
3. Limonis oleum. *D.* 1–5 mins.

Used as an antiscorbutic and refrigerant in scurvy and fevers. The oil acts as rubefacient and carminative in rheumatism and dyspepsia.

III. Aegle marmelos.—*Part used:*

1. Belæ fructus. Bael fruit, about the size of a large orange; rind, grey; generally in pieces.
   - *a.* Extractum belæ liquidum. *D.* 1–4 drs.
     Used as an astringent in dysentery.

BYTHNERIACEÆ.

I. Theobroma cacao, *from the seeds of which is expressed:*

1. Oleum theobromæ (cacao butter).

Used to make suppositories.

Guttiferæ.

I. Garcinia morella. Variety, pedicellata. The gum resin collected in bamboos and dried forms.—*Part used:*

1. Gambogia, gamboge. *D.* 1–5 grs.
   a. Pilula cambogiæ composita. *D.* 5–15 grs. The comp. powder of cinnamon, gamboge, barbadoes aloes—an ounce of each; take of syrup a sufficiency, and hard soap 2 ounces.
   Used as a drastic purgative in dropsies.

Zygophyllaceæ.

I. Guaiacum officinale.—*Parts used:*

1. Guaiaci lignum. *Used* in decoctum sarsæ comp.
2. Guaiaci resina. A natural exudation, obtained by incisions and heat. Dark brown masses, with greenish tinge. *D.* 10–30 grs.
   a. Mistura guaiaci. *D.* $\frac{1}{2}$–2 oz.
   b. Tinctura guaiaci ammoniata. *D.* $\frac{1}{2}$–1 dr.
   Used as a diaphoretic and alterative in quinsy, gout, and chronic rheumatism.

Rutaceæ.

I. Barosma—betulina, crenulata, and serratifolia.—*Part used:*

1. Buchu folia. Buchu leaves.
   a. Infusum buchu. *D.* 1–2 oz.
   b. Tinctura buchu. *D.* 1–2 drs.
   Used as a diuretic and sedative in catarrh of the bladder.

II. Gallipea cusparia. Angustura bark.—*Part used:*

1. Cuspariæ cortex. Cusparia bark.
   a. Infusum cuspariæ. *D.* 1–2 oz. Made with water at 120° F.
   Used as a stomachic tonic in dyspepsia and debility.

Simarubaceæ.

I. Picræna excelsa.—*Part used:*

1. Quassiæ lignum. Quassia wood. Occurs in chips of a light yellow colour.

a. Tinctura quassiæ. *D.* ½–2 dr.
b. Infusum quassiæ. *D.* 1–2 oz. Made with cold water.
c. Extractum quassiæ. *D.* 2–5 grs.
Used as a bitter stomachic in dyspepsia.
The infusion is used as an injection to kill ascarides.

CANELLACEÆ.

I. Canella alba.—*Part used :*
1. Canellæ albæ cortex (the bark). *D.* 10–30 grs.
Used as an aromatic stimulant and tonic. Contained in vinum vitæ.

VITACEÆ.—*The Vine Order.*

I. Vitis vinifera.—*Part used :*
1. Uvæ. Raisins, the grape dried in the sun.
Used in compound tincture of cardamoms and tincture of senna.

Sub-Class II.—Calycifloræ.

AMYRIDACEÆ.

I. Balsamodendron myrrha.—*Part used :*
1. Myrrha. *D.* 10–30 grs. A gum resin exuding naturally.
a. Tinctura myrrhæ. *D.* ½–1 dr.
b. Pilula aloes et myrrhæ. *D.* 5–10 grs.
Used as an astringent and expectorant in bronchitis, and in sore mouth. The pill is used as a purgative and emmenagogue in amenorrhœa.

II. Canarium commune.—*Part used :*
1. Elemi. The resinous exudation.
a. Unguentum elemi. Applied to indolent ulcers.

LEGUMINOSÆ. $\underline{\overset{\frown}{5.}\ \ 5.\ \ \overset{\frown}{9}+1.}$ * 1.—*The Pea Family.*

The sepals, petals, and stamens unite together to form a calyx tube, as indicated by the bracket passing below the formula. Sepals, five, gamosepalous ; the odd sepal is anterior, the reverse of a typical flower. Petals, five, polypetalous. The petals are arranged in a manner peculiar to leguminosæ. The odd petal, instead of being

* The brackets above indicate union of the individual constituents of a whorl ; the bracket below implies adhesion of different whorls.

anterior, is posterior, and is called the "standard" or "vexillum." The two petals, within the standard, lie like wings on the parts within, and are called the "alæ." On removing the alæ, the two remaining petals are seen to form a "keel" or "carina." Stamens, ten; nine in one bundle, and one standing apart by itself. Hence the formula is written $\widehat{9}+1$, and the stamens are said to be *diadelphous*. Pistil, single. Fruit, or legume, or lomentum. Seeds, exalbuminous. Habitat, generally distributed.

Properties.—Demulcent, sweet, diuretic, astringent, purgative, stimulant, expectorant, mydriatic, and colouring agent.

Sub-Orders of Leguminosæ.

A. PAPILIONACEÆ.—Flowers truly papilionaceous.

I. Glycyrrhiza glabra.—*Part used:*
- 1. Glycyrrhizæ radix.
  - *a.* Extractum glycyrrhizæ. *D.* 10-30 grs.
  - *b.* Extractum glycyrrhizæ liquidum. *D.* 1 dr.
  - *c.* Pulvis glycyrrhizæ compositus. *D.* 30-60 grs. Liquorice and senna, one part of each, with three parts sugar.

  Used as a demulcent in cough, and as a vehicle. The powder acts as a purge.

II. Astragalus verus.—*Part used:*
- 1. Tragacantha. The resinous exudation.
  - *a.* Mucilago tragacanthæ. *D.* 1 oz. upwards.
  - *b.* Pulvis tragacanthæ compositus. *D.* 10-60 grs. Tragacanth, starch, and gum, one part of each; refined sugar, three parts.

III Sarothamnus scoparius (broom).—*Part used:*
- 1. Scoparii cucumina (broom tops, fresh or dried).
  - *a.* Succus scoparii, got by expression. *D* 1-2 drs.
  - *b.* Decoctum scoparii. *D.* 2-4 drs.

  Used as a diuretic in dropsies.

IV. Pterocarpus santalinus (red sandal wood).

  Used as a colouring agent in comp. tinct. of lavender.

V. Pterocarpus marsupium.—*Part used:*
- 1. Kino (the inspissated juice obtained by incising the trunk). Occurs in angular reddish-

black fragments, with a shining surface. *D.* 10–30 grs.

a. Tinctura kino (1 in 10). *D.* ½–2 drs.

b. Pulvis kino compositus (1 in 20 of opium). *D.* 5–20 grs. Kino, 15 parts; opium, 1 part; cinnamon, 4 parts.

c. Pulvis catechu compositus (*see* Catechu).

Used as an astringent in catarrh of the stomach and small intestine.

VI. Myroxylon Pereiræ.—*Part used:*

1. Balsamum peruvianum (Peru balsam). The exudation from the stem, got by charring and removing the bark. *D.* 10–60 mins. A treacle-like substance, with acrid aromatic taste.

Used as a stimulant and expectorant in bronchitis and rheumatism, and as an external application in bed-sores.

VII. Myroxylon toluifera.—*Part used:*

1. Balsamum tolutanum (Tolu balsam). An exudation from incised bark. *D.* 10–20 grs. A resin-like substance, tastes like Peru balsam.

a. Tinctura tolutana. *D.* 20–60 mins.

b. Syrupus tolutanus. *D.* 1–2 drs.

Used in the same diseases as Peru balsam.

VIII. Physostigma venenosum.—*Part used:*

1. Physostigmatis faba (Calabar bean). *D.* 1–4 grs.

a. Extractum physostigmatis. *D.* $\frac{1}{16}$–¼ grs.

Used to contract the pupil in eye diseases. In large doses it paralyses the action of the spinal cord, and depresses the heart. It is administered in cases of chorea, tetanus, and in general paralysis of the insane. The physiological effects of the drug are pronounced, but its use in disease is doubtful.

B. Cæsalpineæ.—Corolla imbricated; odd petal internal.

I. Hæmatoxylum campechianum. *Part used:*

1. Hæmatoxyli lignum (logwood).

a. Decoctum hæmatoxyli. *D.* 1–2 oz.

b. Extractum hæmatoxyli. *D.* 10–30 grs.

Used as an astringent in dysentery.

II. 1. Cassia lanceolata } Senna Alexandrina.
2. Cassia obovata }

3. Cassia elongata. Senna Indica.

Part used.—The leaves. Leaves of Colutea arborescens, Solenostemma argel, are apt to be mistaken for senna. The senna leaves are known by being unequally oblique at the base.

Active Principle.—Cathartic acid, a glycocide; it is stated to have the formula :—

$$C_{180}H_{192}N_4SO_2.$$

Insoluble in water, alcohol, or ether; but its alkaline and earthy salts are soluble. Besides the acid, the leaves yield a yellow colouring matter, a volatile and fixed oil, albumen, malic acid, tartrate of lime, acetate of potash, lignin, &c.

Preparations:

a. Confectio sennæ (1 in 11). *D.* 60–120 grs.
b. Infusum sennæ (1 in 10). *D.* 1–2 oz.
c. Syrupus sennæ (1 in 2). *D.* 1 dr.
d. Tinctura sennæ (1 in 8). *D.* 1–4 drs.
e. Mistura sennæ composita. *D.* 1–1½ oz.
Sulphate of magnesia, 4 oz.
Tincture of senna, 2½ oz.
Compound tinct. of cardamoms, 10 drs.
Extract of liquorice, ½ oz.
Infusion of senna, to 1 pt.

Used as a purge in constipation and febrile conditions.

III. Cassiæ fistula (pudding pipe tree). *Part used:*

1. Cassiæ pulpa (cassia pulp). *D.* 120 grs. The pulp of the pod.

Used as a laxative.

IV. Tamarindus indica. *Part used:*

1. Tamarindus (tamarind). *D.* 1½ oz. The pulp preserved.

Used as a refrigerant and laxative in febrile conditions and in constipation.

V. Copaifera multijuga. *Part used:*

1. Copaiba (copaiva). *D.* 15–60 mins. An oleoresin, flowing from the incised trunk. A yellow oily liquid.
2. Copaibæ oleum. *D.* 5–20 mins. Made by distillation from copaiba. A colourless liquid.

Used, as a stimulant to the urinary mucous membrane, in gonorrhœa and cystitis; also as a diuretic in dropsy.

C. Mimoseæ. Flower, regular; corolla valvate.

I. Acacia.—*Part used:*
  1. Acaciæ gummi. *D. ad lib.*
    a. Mucilago acaciæ. *D. ad lib.*
      Used as a demulcent to suspend powders.

II. Indigofera.—*Part used:*
  1. Indigo. A blue pigment.
    a. Solution of indigo.
      Used as a test for chlorine.

Rosaceæ. $\underline{|\ \widehat{5.\ 5}.\ \infty\ |}\ \infty$. *Rose Family.*

Sepals, five, gamosepalous; petals five, polypetalous; the corolla is typical of the order, and is called the rosaceous corolla; stamens indefinite, perigynous. All these whorls, as the bracket below the formula indicates, unite to form a calyx tube. Pistils, indefinite; ovaries, free or coherent; seeds, exalbuminous. Fruit, an achene, as in the strawberry; a drupe, as in the prune; a pome, as in the apple; or an etærio, as in the raspberry. The plants occur as herbs, shrubs, or trees; leaves opposite, stipulate. Habitat, generally distributed.

Properties.—Astringent, sedative, anodyne, anthelmintic, and demulcent.

I. Rosa centifolia (cabbage rose).—*Part used:*
  1. Rosæ centifoliæ petala (fresh petals).
    a. Aqua rosæ.
      Used as a vehicle for lotions, and in mist. ferri co.

II. Rosa gallica.—*Part used:*
  1. Rosa gallicæ petala (red rose petals); flower buds).
    a. Infusum rosæ acidum. *D.* 1–2 oz.
    b. Confectio rosæ gallicæ. *D.* 60 grs.
    c. Syrupus rosæ gallicæ. *D.* 1 dr.
      Used as an astringent, to colour mixtures, to make pills, and as a gargle.

III. Rosa canina.—*Part used:*
  1. Rosæ caninæ fructus (hips).
    a. Confectio rosæ caninæ. *D.* 60 grs.
      Used as the other roses.

IV. Amygdalus communis.—*Part used:*
1. The seed of Amygdala dulcis (sweet almond). Composed of oil, amygdalin, casein, and emulsin.
a. Pulvis amygdalæ compositus. *D.* 60–120 grs. Almonds, 8; sugar, 4; gum acacia, 1.
b. Mistura amygdalæ. *D.* 1–2 oz.

V. Amygdalus communis.—*Part used:*
1. The seed of Amygdala amara (the bitter almond). The bitter almond contains amygdalin in addition to other constituents of the sweet almond. Amygdalin with emulsin, when the bitter almond is bruised and moistened or chewed, develops hydrocyanic acid (*see* Acids).
2. Oleum amygdalæ. *D.* 1–4 drs. From both kinds of almonds. Pale yellow in colour.
Used to make ointments. Should not be given internally.

VI. Prunus domestica.—*Part used;*
1. Prunum (the fruit).
Used to make conf. sennæ; it acts as a laxative.

VII. Prunus laurocerasus.—*Part used:*
1. Laurocerasi folia. Fresh cherry laurel leaves, yield bitter almond oil, and hydrocyanic acid.
a. Aqua laurocerasi (laurel water). *D.* 5–30 m.
Used as hydrocyanic acid.

VIII. Brayera anthelmintica.—*Part used:*
1. Cusso (kousso). Flowers and tops. *D.* $\frac{1}{4}$–$\frac{1}{2}$ oz.
a. Infusum cusso. *D.* 4–8 oz. Active principle, koussin.
Used as an anthelmintic in tapeworm.

MYRTACEÆ.

I. Caryophyllus aromaticus.—*Part used:*
1. Caryophyllum (cloves). The unexpanded buds.
a. Infusum caryophylli. *D.* 1–2 oz.
2. Caryophylli oleum. *D.* 1–5 mins.
Used as a stimulant and carminative, as a vehicle and adjunct.

II. Eugenia pimenta.—*Parts used:*
1. Pimenta (pimento). Unripe fruit. *D.* 5–20 grs.
a. Aqua pimentæ. *D.* 1–2 oz.
2. Pimentæ oleum. *D.* 1–5. m.
Used as cloves.

III. Melaleuca minor.—*Part used:*

1. Cajuputi oleum (oil of cajeput from the leaves). *D.* 1–5 m.

   a. Spiritus cajuputi. *D.* 20–60 mins.

Used as a rubefacient, antispasmodic, and diaphoretic in rheumatism, colic, and hysteria.

IV. Punica granatum.—*Part used:*

1. Granati radicis cortex (pomegranate bark).

   a. Decoctum granati radicis. *D.* 2–6 oz.

Used as an astringent and anthelmintic.

CUCURBITACEÆ. *The Gourd Family.*

The plants are unisexual,—

Male $\mid \underline{\overset{\frown}{5}.\ \overset{\frown}{5}.\ 3.} \mid 0.$ Female $\mid \underline{\overset{\frown}{5}.\ \overset{\frown}{5}.} \mid 0.\ 3.$

A plant possessing male organs is indicated by the symbol ♂, the female by ♀.

Sepals, five, gamosepalous; petals, five, gamopetalous stamens, marked by sinuous lines. Ovary, inferior—*i.e.*, covered over by calyx tube. Seeds, exalbuminous. The fruit is a pepo—*i.e.*, an inferior syncarpous fruit, succulent and indehiscent. Habitat, hot climates.

Properties—purgative.

To this order belong—melons, gourds, cucumbers, vegetable marrows, &c.

I. Citrullus colocynthis.—*Part used:*

1. Colocynthidis pulpa (colocynth pulp). *D.* 2–8 grs. Active principle colocynthin, exists in the pulp.

   a. Extractum colocynthidis compositum. *D.* 3–10 grs. Colocynth, 6; extract of socotrine aloes, 12; resin of scammony, 4; hard soap, 3; cardamom seeds, 1; proof spirit.

   b. Pilula colocynthidis composita (1 in 6). *D.* 5–10 grs. Colocynth, 4; Barbadoes aloes, 8; scammony, 8; sulphate of potash, 1; oil of cloves, 1; distilled water.

   c. Pilula colocynthidis et hyoscyami. *D.* 5–10 grs. Comp. colocy. pill, 2; and tinct. hyoscy. 1.

   Used as a drastic purgative in constipation and dropsy. It acts both on the muscular and secreting structures of the intestines, especially the large. It should not be given in pregnancy, menor-

rhagia, or peritoneal inflammation. In large doses it has proved fatal.

II. Ecbalium officinarum.—*Parts used:*

1. Ecbalii fructus.
2. Elaterium. *D.* $\frac{1}{16}$–$\frac{1}{2}$ grs. This is a sediment from the expressed juice of the fruit. The active principle contained in the juice is the alkaloid, *elaterine*, or mimordicine.
   - *a.* Pulvis elaterii compositus (1 10). *D.* $\frac{1}{2}$–5 grs. Elaterium, and sugar of milk.

   Used as a drastic purgative and cathartic in dropsy.

UMBELLIFERÆ. $\underline{|\,\widehat{5}.\ 5.\ 5.\,|}$ $\widehat{2}$. — *The Parsley Family.*

Sepals, five, gamosepalous; petals, five, polypetalous; stamens, epigynous. Bracts surround the spot where the rays of the umbel arise, and are called involucres; secondary bracts exist around the flowers, and are called involucels. Fruit is a cremocarp—*i.e.*, an inferior syncarpous fruit, dry and indehiscent. The fruit separates, when ripe, into two parts, called mericarps, and each mericarp is supported upon a kind of stalk or carpophore. Vittæ are characteristic of this Order; there are intercellular spaces in the fruit, filled by a peculiar fluid, which contains the active principle of the plant. Seeds, albuminous. Habitat, temperate climates.

Properties are very varied: stimulant, antispasmodic, expectorant, or may be a deadly poison.

I. Conium maculatum.—*Parts used:*

1. Conii folia (hemlock leaves). *D.* 2–8 grs. Yield conia, methylconia, and a volatile oil.
   - *a.* Cataplasma conii.
   - *b.* Extractum conii (green extract). *D.* 2–6 grs. *From hence are derived—*
   - *c.* Pilula conii composita. *D.* 5–10 grs. Extract of conium, 5; ipecacuanha, 1; treacle q.s.
   - *d.* Vapor conii. Extract of conium, 1; liquor potassæ, 1; water, 10.
2. Succus conii, juice expressed from leaves. *D.* 2 dr.
3. Conii fructus.
   - *a.* Tinctura conii (1 in 8). *D.* $\frac{1}{2}$ dr.

Used in nervous diseases, such as chorea, and in coughs as a sedative and antispasmodic. It causes diminution of the sensibility and the motor

power by acting on the spinal cord and end organs of the motor nerves. Externally it is applied to cancers and painful ulcers.

II. Narthex assafœtida.—*Part used:*

1. Assafœtida (the gum resin). *D.* 5–30 grs.
   - *a.* Enema assafœtida (30 grs. in 4 oz.).
   - *b.* Spiritus ammoniæ fœtidus. *D.* $\frac{1}{2}$–1 dr.
   - *c.* Tinctura assafœtida (1 in 8). *D.* $\frac{1}{2}$–1 dr.
   - *d.* Pilula assafœtidæ composita (1 in $3\frac{1}{2}$). *D.* 5–15 grs. Assafœtida, galbanum, myrrh, treacle.
   - *e.* Pilula aloes et assafœtidæ (1 in 4). *D.* 4–10 grs.

Used as a stimulant, antispasmodic, and carminative, in hysteria, asthma, chronic bronchitis, and tympanites.

III. Ferula galbaniflua.—*Part used:*

1. Galbanum (the resinous exudation). *D.* 10–30 grs.
   - *a.* Emplastrum galbani.

Used internally as a stimulating expectorant in bronchitis, externally as a stimulant plaster.

IV. Dorema ammoniacum.—*Part used:*

1. Ammoniacum (a resinous exudation). *D.* 10–30 grs.
   - *a.* Mistura ammoniaci. *D.* $\frac{1}{2}$–1 oz.
   - *b.* Emplastrum ammoniaci cum hydrargyro.

Used as galbanum.

V. Pimpinella anisum (aniseed).—*Parts used:*

1. Anisi oleum, from fruit. *D.* 2–5 mins.
2. Essentia anisi (rectified spirit, oil of aniseed). *D.* 10–20 mins.

Used as an aromatic and stimulant in flatulence.

VI. Fœniculum dulce.—*Part used:*

1. Fœniculi fructus (sweet fennel fruit).
   - *a.* Aqua fœniculi. *D.* 1–2 oz.

Used as aniseed.

VII. Coriandrum sativum (coriander).—*Parts used:*

1. Coriandri fructus. *D.* 10–30 grs.
2. Oleum coriandri. *D.* 2–5 mins.

Used as a stimulant carminative mixed with purgatives.

VIII. Carum carui.—*Parts used:*

1. Carui fructus (caraway fruit).
   - *a.* Aqua carui. *D.* 1–2 oz.
2. Carui oleum. *D.* 2–5 mins.

Used as coriander.

IX. Anethum graveolens (dill).—*Parts used:*
1. Anethi fructus (dill fruit).
a. Aqua anethi. *D.* 1–2 drs. for infants.
2. Anethi oleum. *D.* 2–5 mins.
Used as coriander. Largely used in cases of flatulence in children.

X. Euryangium sumbul.—*Part used:*
1. Sumbul radix.
a. Tinctura sumbul. *D.* 10–30 mins.
Used as a nervine stimulant.

Cinchonaceæ.

I. Cinchona calisaya.—*Parts used:*
1. Cinchonæ flavæ cortex (yellow bark). *D.* 10–60 grs. Occurs as yellow quills or flat pieces. Yields quinine, cinchonine, cinchonidine, quinidine, quinamine, &c. This variety is richest in quinine.
a. Decoctum cinchonæ (1 in 16). *D.* 1–2 oz. Boiling the powdered bark, 1, in water, 15.
b. Infusum cinchonæ (1 in 20). *D.* 1–2 oz. Infusing powdered bark, 1, in water, 20.
c. Extractum cinchonæ liquidum (1 part to 4 of bark). *D.* 10–60 mins. Powdered bark, 16; rectified spirit, 1; water, *ad lib.* Macerate, percolate, and evaporate.
d. Tinctura cinchonæ (1 in 5). *D.* 1–2 drs. Macerating powdered bark, 1, in proof spirit, 5.
2. Quiniæ sulphas. *D.* 1–10 grs. Macerating the yellow bark with hydrochloric acid precipitated with soda, neutralizing with sulphuric acid, and crystallizing (*see* Alkaloids).
a. Pilula quiniæ (1 in $1\frac{1}{3}$). *D.* 2–10 grs. Sulphate of quinine and confection of roses.
b. Tinctura quiniæ (1 in 60). *D.* 1–2 drs. Sulphate of quinine and tincture of orange peel.
c. Tinctura quiniæ ammoniata (1 in 60). *D.* $\frac{1}{2}$–2 drs. Sulphate of quinine, $\frac{1}{7}$; solution of ammonia, 1; proof spirit, 7.
d. Vinum quiniæ (1 in 480). *D.* $\frac{1}{2}$–1 oz. Sulphate of quinine, 20 grs.; citric acid, 30 grs.; orange wine, 1 pint.
Used as cinchona.

II. Cinchona condaminea.—*Parts used:*

1. Cinchonæ pallidæ cortex (pale bark). *D.* 10–60 grs. Occurs as greyish quills, spotted with lichens. This variety is richest in cinchonine.

   a. Tinctura cinchonæ composita (1 in 10). *D.* 1–2 drs. Pale cinchona bark, 2; bitter orange peel, 1; serpentary, $\frac{1}{2}$; saffron, $\frac{1}{7}$; powdered cochineal, $\frac{1}{14}$; and proof spirit, 20.

2. Cinchonia (cinchonine). An alkaloid, obtained chiefly from the pale bark. It is similar in action to quinine, believed to be two-thirds less efficacious, hence it is given in larger doses, 20–40 grs.

III. Cinchona succirubra.—*Part used:*

1. Cinchonæ rubræ cortex (red bark). *D.* 10–60 grs. Occurs in brownish red quills or flat pieces. Rich in both quinine and cinchonine.

   Used as a tonic, antiperiodic, astringent, antipyretic and stimulant. It is especially useful in malaria, debility, and neuralgia, and in lowering the temperature in high fevers.

IV. Cephaëlis ipecacuanha.—*Part used:*

1. Ipecacuanha (the root). *D.* as an emetic, 15–30 grs.; as an expectorant, $\frac{1}{2}$–2 grs. Known by the annulated root, the swellings presenting a beaded look and faint nauseous odour.

   a. Vinum ipecacuanhæ (1 in 20). *D.* as an emetic, 3–6 drs.; as an expectorant, 5–40 mins.

   b. Trochisci ipecacuanhæ ($\frac{1}{4}$ gr. in each). D. 1–3.

   c. Trochisci morphiæ et ipecacuanhæ. *D.* 1–6. ($\frac{1}{12}$ gr. ipecacuanha, $\frac{1}{36}$ gr. morphia in each.)

   d. Pulvis ipecacuanhæ compositus. Dover's powder (*see* Opium).

   e. Pilula ipecacuanhæ cum scilla (1 of opium in 23). *D.* 5–10 grs. Pulv. ipecac. co., squill, ammoniacum, and treacle.

   f. Pilula conii composita (*see* Conium).

   Used as an emetic, expectorant, diaphoretic, astringent in croup, bronchitis, dysentery, and catarrhal affections.

V. Uncaria gambir.—*Part used :*

1. Catechu pallidum (pale catechu). *D.* 10–30 grs. An extract from leaves and young shoots. Occurs in cubes about one inch in diameter, reddish brown in colour.
   - *a.* Pulvis catechu compositus (2 in 5). *D.* 20–60 grs. Catechu, kino, rhatany, cinnamon, and nutmeg.
   - *b.* Infusum catechu. *D.* 1–2 oz.
   - *c.* Tinctura catechu. *D.* $\frac{1}{2}$–2 drs.
   - *d.* Trochisci catechu. *D.* 1–3.

   Used as an astringent in catarrhal diseases of alimentary canal.

VALERIANACEÆ. $\underline{\widehat{5.}\ \underline{\widehat{5.}\ 3.}\ \widehat{3.}}$

Sepals, five, gamosepalous; petals, five, gamopetalous; corolla, tubular. Stamens, epipetalous—*i.e.*, inserted on the corolla; this is indicated by the short bracket below. The large bracket indicates that the calyx is adherent to the ovary, and consequently all the parts are inserted together into the disc. Seed, exalbuminous. Habitat, temperate zone.

Properties.—Stimulant and antispasmodic.

I. Valeriana officinalis.—*Part used :*

1. Valerianæ radix. *D.* 15–30 grs. Occurs as close bundles of fibrous roots growing from a rhizome.
   - *a.* Infusum valerianæ (1 in 40). *D.* 1–2 oz.
   - *b.* Tinctura valerianæ (1 in 8). *D.* $\frac{1}{2}$–2 drs.
   - *c.* Tinctura valerianæ ammoniata (1 in 8). *D.* $\frac{1}{2}$–$1\frac{1}{2}$ drs.

   Used as an antispasmodic and stimulant in hysteria.

   For sodæ valerianas and zinci valerianas (*see* Soda and Zinc).

COMPOSITÆ. $\underline{\widehat{5.}\ \underline{\widehat{5.}\ \widehat{5.}}\ \widehat{1.}}$

The many florets of which a composite plant is made up are arranged on a flattened disc, or receptacle. Surrounding the receptacle are a number of leaf-like appendages, as in the daisy and dandelion. These are a whorl of bracts, or phyllares, constituting the involucre; around each floret another ring of bracts called paleæ exists, con-

stituting the involucels. The florets of such a plant as the dandelion are all alike; but, in the daisy and others, the florets of the ray or circumference differ from those of the disc or centre. The formula given is the formula for each floret. Sepals, five, gamosepalous. At the period of ripening of the fruit, the sepals get split up into five shreds, constituting a pappus. The fine filaments become intermingled, and the pappus or "down" floats away to deposit the seeds contained in it at a spot, it may be, miles away. Petals, five, gamopetalous. In the dandelion, the florets have all a ligulate or strap-shaped corolla; in the daisy, the florets of the ray have a ligulate, whilst the florets of the disc have a tubular, corolla. Stamens, epipetalous—*i.e.*, inserted on the corolla, as the small bracket in the formula indicates. Anthers, syngenesious —*i.e.*, adherent by their anthers. Pistil, one; style, bifid. Ovary, one-celled and one-seeded. Seed, ex-albuminous. Fruit, a cypsela—*i.e.*, an inferior syncarpous fruit, dry and indehiscent; in fact, an inferior achene, having the calyx attached as a pappus. Habitat, generally distributed. Occurs chiefly as herbs.

Properties.—Bitter, tonic, anthelmintic, alterative, stimulant, &c.

I. Anacyclus pyrethrum.—*Part used:*

1. Pyrethri radix (pellitory root).
    a. Tinctura pyrethri.
        Used to wash out the mouth with.

II. Artemisia.—*Parts used:*

1. Santonica. The unexpanded flower heads. *D.* 10–60 grs.
2. Santoninum.—*D.* For a child, 1–3 grs.; for an adult, 2–6 grs.
    Used as an anthelmintic in round and thread worms.

III. Anthemis nobilis.—*Parts used:*

1. Anthemidis flores (chamomile).
    a. Infusum anthemidis. *D.* 1–4 oz.
2. Anthemidis oleum. *D.* 1–5 mins. Obtained by distillation from the flowers.
    a. Extractum anthemidis. *D.* 2–10 grs.
        Used as an aromatic stomachic and tonic in dyspepsia.

IV. Taraxacum dens leonis.—*Part used:*

1. Taraxaci radix (dandelion).
    a. Succus taraxaci. *D.* 1–2 drs.

b. Extractum taraxaci. *D.* 5–30 grs.
c. Decoctum taraxaci. *D.* 2–4 oz.
Used as a cholagogue in congestive diseases of liver.

V. Lactuca virosa.—*Part used:*
1. Lactuca (flowering plant).
a. Extractum lactucæ. *D.* 5–30 grs.
Used as a narcotic.

VI. Arnica montana.—*Part used :*
1. Arnicæ radix (arnica root).
a. Tinctura arnicæ. *D.* $\frac{1}{2}$–1 dr.
Used chiefly as an external application for bruises.

Lobeliaceæ.

I. Lobelia inflata.—*Part used:*
1. Lobelia (the flowering herb).
a. Tinctura lobeliæ. *D.* 10–30 mins.
b. Tinctura lobelia ætherea. *D.* 10–30 mins.
Used as an emetic, cathartic, expectorant, and diaphoretic in asthma.

Ericaceæ.

I. Arctostaphylos (uva ursi).—*Part used:*
1. Uvæ ursi folia. Bearberry leaves. *D.* 10–30 grs.
a. Infusum uvæ ursi. *D.* 1–2 oz.
Used as an astringent and diuretic in derangement of mucous membrane of bladder and urethra.

Sapotaceæ.

I. Isonandra gutta.—*Part used:*
1. Gutta percha (the dried juice).
a. Liquor gutta percha. Dissolve in chloroform; add carbonate of lead, and decant.
Used to make splints, and contained in charta sinapis.

Styraceæ.

I. Styrax benzoin.
1. Benzoinum (the dried balsam). *D.* 10–30 grs.
a. Acidum benzoicum. *D.* 10–15 grs. Made by dry distillation.
b. Tinctura benzoini composita. *D.* $\frac{1}{2}$–1 dr.; benzoin, 4; storax, 3; balsam of Tolu, 1; socotrine aloes, $\frac{2}{3}$; rectified spirit, 40.

Used as a stimulant and expectorant in bronchitis; and as a diuretic and alterative in inflammation of the bladder.

2. Ammoniæ benzoas (*see* Ammonia).

OLEACEÆ.

I. Olea Europæa.—*Parts used:*
   1. Olivæ oleum. From ripe fruit by expression. *D.* 1 dr.–1 oz.
   2. Sapo durus (hard soap). Made by boiling olive oil with soda.
      a. Emplastrum ceratri saponis.
      b. Emplastrum saponis.
      c. Linimentum saponis (opodeldoc).
   3. Sapo mollis (soft soap). Made by boiling olive oil with potash.
   4. Glycerinum, $C_3H_8O_3$. A sweet principle, made from fat and vegetable oils by decomposition by superheated steam.
      a. Glycerinum acidi carbolici (1 in 4).
      b. Glycerinum acidi gallici (1 in 4).
      c. Glycerinum acidi tannici (1 in 4).
      d. Glycerinum boracis (1 in 4).
      e. Glycerinum amyli (glycerine, 8; starch, 1).

   Use.—Olive oil is used as an emollient and demulcent in poisoning. Soaps are used to make plasters. Glycerine is used as an emollient in skin diseases. The other preparations are used according to the predominating drug in the compound.

II. Fraxinus ornus and F. rotundifolia.—*Part used:*
   1. Manna (an exudation from the bark). *D.* ½ oz. *Used* as a laxative for children.

LOGANIACEÆ.

I. Strychnos nux vomica.—*Parts used:*
   1. Nux vomica. The seeds, about ½ to ¾ of an inch in diameter, grey, depressed in the centre, thickly covered with hairs, a slight spur on margin; yields strychnia, brucia, and strychnic acid.
      a. Extractum nucis vomicæ (1 lb. seeds in 1 oz.) *D.* ¼–2 grs.
      b. Tinctura nucis vomicæ (2 oz. seeds in 1 pt.). *D.* 10–20 min.

2. Strychnia (*see* Alkaloids). *D.* $\frac{1}{30}$–$\frac{1}{8}$ gr.
   a. Liquor strychniæ (4 grs. in 1 oz.) *D.* 5–10 min. Dissolving strychnia in rectified spirit and accidulating with HCl.

   Used on account of its stimulating action on spinal cord and spinal ganglia. It is administered in dyspepsia, constipation, debility, paralysis, and impotence.

Gentianaceæ. $\widehat{5}.\ \underline{|\,\widehat{5}.\ 5.\,|}\ \widehat{2}.$

Sepals five, gamosepalous; calyx, persistent—*i.e.*, it lasts through the winter. Petals, five, gamopetalous; corolla, convolute—*i.e.*, rolled up. Stamens, epipetalous, as the bracket implies; fruit, a capsule; seeds, albuminous. Habitat, generally distributed.

Properties.—A bitter tonic.

I. Gentiana lutea.—*Part used:*

1. Gentianæ radix. *D.* 10–30 grs. Occurs in long yellowish-brown pieces. Active principle, gentio-picrin and gentianic acid.
   a. Tinctura gentianæ compositæ (1 in 13). *D.* $\frac{1}{2}$–2 drs. Gentian root, bitter orange peel, cardamom seeds, and proof spirit.
   b. Infusum gentianæ compositum (1 in 80). *D.* 1–2 oz. Gentian root, bitter orange-peel, fresh lemon-peel, and boiling water.
   c. Mistura gentianæ (1 in 40.) *D.* $\frac{1}{2}$–1 oz.
   d. Extractum gentianæ. *D.* 2–10 grs.

   Used as a bitter tonic in dyspepsia and debility.

II. Ophelia chirata.—*Part used:*

1. Chirata (chiretta). The entire plant occurs as pale brown stems. Active principle, ophelic acid and chiratin.
   a. Infusum chiratæ, with water at 120° F. *D.* 1–2 oz.
   b. Tinctura chiratæ. *D.* $\frac{1}{2}$–2 dr.

   Used as gentian.

Convolvulaceæ. $\widehat{5}.\ \underline{|\,\widehat{5.\ 5}.\,|}\ 2.$

Sepals, five, gamosepalous, imbricated; petals, five, gamopetalous; stamens, five, epipetalous; ovary, two-celled; seeds, albuminous. The plants are herbs, usually twining. Habitat, the officinal plants are tropical.

Properties.—Purgative.

I. Convolvulus scammonia.—*Parts used;*

1. Scammoniæ radix. Occurs as greyish-brown cylindrical pieces, 2 to 3 inches in diameter
2. Scammonium. *D.* 5–10 grs. A gum resin, obtained by incisions in the living root. Occurs in irregular greenish masses, brittle, coated with powder, having the smell of cheese. Active principle, jalapin.
    - *a.* Confectio scammonii (1–3). *D.* 10–30 grs.
    - *b.* Pulvis scammonii compositus (1–2). *D.* 10–20 grs. Scammony, 4; jalap, 3; ginger, 1.
3. Scammoniæ resina. *D.* 3–8 grs. The resin, obtained from the dried root by maceration with alcohol, occurs in brown translucent brittle pieces.
    - *a.* Pilula scammonii composita (1–3). *D.* 5–15 grs. Resin of scammony, 1; resin of jalap, 1; curd soap, 1; tincture of ginger, 1; rectified spirit, 2.
    - *b.* Mistura scammonii (2 grs. in 1 oz.). *D.* $\frac{1}{2}$–2oz.

Used as a cathartic in constipation and dropsy. As a derivative in cerebral disease.

II. Exogonium purga.—*Parts used:*

1. Jalapa (the dried tuber). Occurs in dark brown ovoid tubercles, about the size of a Tangerine orange.
    - *a.* Pulvis jalapæ compositus (1–3). *D.* 10–30 grs. Jalap, 5; acid tartrate of potash, 9; ginger, 1.
    - *b.* Tinctura jalapæ ($54\frac{1}{2}$ grs.–1 oz.). *D.* $\frac{1}{2}$–2 drs.
    - *c.* Extractum jalapæ. *D.* 5–15 grs.
2. Jalapæ resina. *D.* 2–5 grs. Occurs as dark brown opaque fragments. Active principle, jalapin.

Used as scammony.

SOLANACEÆ. $\widehat{5.} \mid \underline{\widehat{5.\ 5.}} \mid \widehat{2.}$

Sepals, five, gamosepalous; petals five, gamopetalous; stamens five, epipetalous; ovary, two-celled; seeds, albuminous; fruit, a berry or capsule. Habitat, generally distributed.

Properties.—Narcotic for the most part.

I. Solanum dulcamara.—*Part used:*

1. Dulcamara (the young branches dried). It occurs as yellowish brown twigs about the size of a goose quill.

a. Infusum dulcamara. *D.* 1–4 oz.

Used as a diaphoretic and diuretic in bronchitis gout, and skin diseases.

II. Capsicum fastigiatum.—*Part used:*

1. Capsici fructus (the ripe fruit). *D.* $\frac{1}{2}$–1 gr. Occurs as scarlet pods. Active principle, capsicin.

a. Tinctura capsici. *D.* 5–20 min.

Used as a stimulant in dyspepsia and diarrhœa; as a gargle it is used in the strength of 10 min. to 1 oz.

ATROPACEÆ.

I. Atropa belladonna. The deadly nightshade (*see* Solanaceæ).—*Part used:*

1. Belladonnæ folia (the leaves). Occurs as brownish leaves less wrinkled than stramonium and with smooth petiole. Active principle atropia, and asparagine.

a. Tinctura belladonnæ (1 in 20). *D.* 5–30 min.

b. Succus belladonnæ. *D.* 5–15 min.

c. Extractum belladonnæ. *D.* $\frac{1}{6}$–1 gr. (*see* Green Extracts.) From the extract are obtained—

d. Unguentum belladonnæ (80 grs. in 1 oz).

e. Emplastrum belladonnæ.

2. Belladonnæ radix. Occurs as a tapering root, 1 to 2 feet long, about 1 inch thick, of a brownish white colour.

a. Linimentum belladonnæ (1 in 1). Made with camphor and spirit from the root.

3. Atropia (made from the root; *see* Alkaloids).

a. Liquor atropiæ (4 grs. in 1 oz.). Made by dissolving atropia in water, and adding rectified spirit.

b. Unguentum atropiæ (1 in 60).

4. Atropiæ sulphas. Made by dissolving atropia in water, neutralizing with sulphuric acid, and evaporating at 100°.

Occurs as a colourless powder.

a. Liquor atropiæ sulphatis (4 grs. in 1 oz).

Uses. Belladonna acts as an anodyne, hypnotic, lactifuge, antispasmodic, mydriatic, diuretic, and vasculo-cardiac stimulant. As an anodyne it should be administered both internally and locally; it is often applied as a supposi-

tory or pessary; each pessary containing $\frac{1}{20}$th gr. of atropia. As an hypnotic, as a substitute for opium. As an antispasmodic in whooping cough, epilepsy, spasmodic stricture of the urethra, &c. As a mydriatic, causing dilatation of the pupil, and allaying pain. As a diuretic it is especially useful in uræmia. As a vasculo-cardiac stimulant it stimulates the circulation by acting through the sympathetic system on the walls of the vessels. As a lactifuge it is best applied as a belladonna plaster.

II. Datura stramonium (the thorn apple).—*Part used:*

1. Stramonii folia (the dried leaves). *D.* 1 gr. upwards.

   Occurs as large dark-green wrinkled leaves; the petiole is smooth. Active principle, daturia.

2. Stramonii semina (the seeds).

   Occur as small, dark brown, kidney-shaped and flattened seeds.

   a. Extractum stramonii. *D.* $\frac{1}{4}$–$\frac{1}{2}$ gr.

   b. Tinctura stramonii (1 in 8). *D.* 10–30 mins.

   Used as belladonna. The leaves are smoked in asthma.

III. Hyoscyamus niger.—*Part used:*

1. Hyoscyami folia (the dried leaves). Distinguished from the two previous by having a woolly stem and a hairy petiole.

   a. Succus hyoscyami. *D.* $\frac{1}{2}$–1 dr.

   b. Extractum hyoscyami. *D.* 5–10 grs. (*see* Green Extracts).

   c. Tinctura hyoscyami (1 in 8). *D.* $\frac{1}{2}$–1 dr.

   Used as belladonna, but not so powerful; often used as an adjunct to prevent griping in purgative medicines.

IV. Nicotiana tabacum.—*Part used:*

1. Tabaci folia (tobacco leaves dried). Active principle, nicotia and nicotiania.

   a. Enema tabaci. 20 grs. of leaves in 8 oz. water.

   Used as an irritant, cardiac sedative, and diuretic; given as snuff in brain diseases, smoke in asthma, and as an enema to produce muscular relaxation in hernia and internal strangulation.

SCROPHULARIACEÆ. $\widehat{5}. \mid \underline{\widehat{5}.\ 4.} \mid \widehat{2}.$

Herbs.—Leaves, alternate, opposite or in whorls. Sepals, five, gamosepalous; petals, five, gamopetalous. Flowers sometimes irregularly labiate. Stamens, didynamous—*i.e.*, two long and two short. Ovary, two-celled. Seeds, albuminous. Habitat, generally distributed.

Properties, sedative, diuretic, and highly poisonous.

1. Digitalis purpurea.—*Part used:*
   1. Digitalis folia. *D.* ½–2 grs. The dried leaves occur as large, wrinkled leaves, with prominent veins on the under side. Active principle, digitalin, and digitoxin, &c. (*see* Alkaloids).
      a. Infusum digitalis (3 grs. in 1 oz.). *D.* 2–4 drs.
      b. Tinctura digitalis (1 in 8). *D.* 5–30 mins.
   2. Digitalium (digitalin). *D.* $\frac{1}{30}$ gr. (*see* Alkaloids).
   Used in cardiac disease and palpitation, to slow the heart and regulate its action. Used in dropsy as a diuretic, especially in cardiac dropsy. Digitalis acts on the cardiac inhibitory fibres of the vagus, and on the muscular wall of the heart directly.

LABIATÆ. $\widehat{5}. \mid \underline{\widehat{5}.\ 4.} \mid \widehat{4}.$—*The Mint Family.*

Herbs.—Stems, square; leaves, opposite. Sepals, five, gamosepalous, persistent—*i.e.*, adherent to fruit after the fall of the leaf. Petals, five, gamopetalous, labiate—*i.e.*, lipped—two petals are combined in upper and three in lower lip. Stamens, epipetalous, didynamous—*i.e.*, two long and two short. Ovary, four-celled. Seeds, no albumen. Fruit, an achene. Habitat, temperate climates.

Properties, stimulant and aromatic.

I. Rosmarinus officinalis (rosemary).—*Part used:*
   I. Rosmarini oleum. From the flowering tops. *D.* 1–5 mins.
      a. Spiritus rosmarini. *D.* ½–1 dr.
         Used as a stimulant in hysteria and headache.

II. Lavandula vera. Lavender.—*Part used:*
   1. Lavandulæ oleum. From the flowers. *D.* 1–5 mins.
      a. Spiritus lavandulæ. *D.* ½–1 dr.
      b. Tinctura lavandulæ composita. *D.* ½–2 drs.

Oil of lavender, oil of rosemary, cinnamon, nutmeg, red sandal wood, and rectified spirit.
Used as a stimulant and carminative in hysteria and nervous affections. *Used* also as a colouring agent.

III. Mentha piperita (peppermint).—*Part used:*
1. Menthæ piperitæ oleum. *D.* 1-5 mins.
a. Spiritus menthæ piperitæ. *D.* ½–1 dr.
b. Essentia menthæ piperitæ. *D.* 10–20 mins.
c. Aqua menthæ piperitæ. *D.* 1–2 oz.
Used as a stimulant and carminative in flatulence, and as an adjunct to purgatives.

IV. Mentha viridis (spearmint). *Part used:*
1. Menthæ viridis oleum. *D.* 1–5 mins.
a. Aqua menthæ viridis. *D.* 1–2 oz.
Used as above.

Sub-Class III. Apetalæ.

POLYGONACEÆ. | 5. 0. 8. | 3.—*The Buckwheat Family.*

Herbs.—Leaves, alternate; stipules, verbate—*i.e.*, the stipules at the base of two leaves are conjoined so as to surround the whole stem—this is characteristic of the order. Sepals, five, gamosepalous, green, persistent—*i.e.*, adherent to the fruit after the fall of the leaf. Petals, wanting. Stamens, episepalous, as the bracket implies, hypogynous. Ovary, one-celled. Fruit, a nut. Seeds, albuminous. Habitat, generally distributed. Properties, tonic, astringent, and purgative.

I. Rheum.—*Part used:*
1. Rhei radix (the dried root). *D.* 1–5 grs. as a stomachic; 10–30 grs. as a purgative. Occurs as variously shaped pieces, often bored with one hole, yellow externally; active principle, chrysophanic and rheo-tannic acids and resin.
a. Extractum rhei. *D.* 5–15 grs.
b. Infusum rhei. (1 in 40.) *D.* 1–2 oz.
c. Vinum rhei. (1 in 14.) *D.* 1–2 drs. Rhubarb, 11; canella alba bark, 1; sherry, 9.
d. Tinctura rhei. (1 in 10.) *D.* 1–2 drs. as a stomachic; ½–1 oz. as a purgative. Rhu-

barb, 8; cardamoms, 1; coriander, 1; saffron, 1; proof spirit, 80.

e. Syrupus rhei. (1 in 16.) *D.* 1–4 drs. Rhubarb, 1; coriander, 1; sugar, 12; rectified spirit, 4; water, 12.

f. Pilula rhei composita. (1 in $3\frac{1}{2}$.) *D.* 5–10 grs. Rhubarb, 16; myrrh, 8; socotrine aloes, 12; hard soap, 8; treacle, 32; oil of peppermint, 1.

g. Pulvis rhei compositus. (1 in $4\frac{1}{2}$.) *D.* 5–10 grs. for children; 20–60 grs. for adults. Rhubarb, 2; light magnesia, 6; ginger, 1.

Used in large doses and in small doses; in the former it acts as a purgative, in the latter as an astringent. In dyspepsia and diarrhœa it is especially useful. The colouring matter is thrown off by the urine, which is apt to assume a deep red colour, resembling hæmaturia.

Myristicaceæ.

I. Myristica officinalis.—*Parts used:*

1. Myristica (nutmeg, the kernel of the seed). *D.* 5–15 grs.
2. Myristicæ oleum (a volatile oil obtained from nutmeg). *D.* 1–5 mins.
   a. Spiritus myristicæ. *D.* 30–60 mins.
3. Myristicæ oleum expressum (a concrete oil).

Used as a stimulant and carminative, to flavour mixtures, and the concrete oil as an adjunct to plasters.

Lauraceæ.

I. Cinnamomum zeylanicum.—*Part used:*

1. Cinnamomi cortex (the inner bark). *D.* 10–20 grs.
   a. Pulvis cinnamomi compositus (1 in 3). *D.* 3–10 grs. Cinnamon bark, 1; ginger, 1; cardamoms, 1.
   b. Tinctura cinnamomi. *D.* $\frac{1}{2}$–2 drs.
   c. Aqua cinnamomi. *D.* 1–2 oz.
2. Cinnamomi oleum. *D.* 1–3 mins.

Used as a tonic, carminative, and astringent.

II. Camphora officinarum.—*Part used:*

1. Camphora. *D.* 1–10 grs. Obtained by sublimation from the wood, in this state it is called crude camphor; it is afterwards purified by re-subliming with lime. It is a solid volatile oil. Camphor must be powdered in the presence of a little rectified spirit.
   - *a.* Linimentum camphoræ. (1 in 5.)
   - *b.* Linimentum camphoræ compositum. (1 in 8.) Camphor, oil of lavender, strong ammonia, and spirit.
   - *c.* Aquæ camphoræ. *D.* 1–2 oz.
   - *d.* Spiritus camphoræ. (1 in 10.) *D.* 10–30 mins.
   - *e.* Tinctura camphoræ composita. *See* Opium.

   Used as an irritant, antiseptic, stimulant, and antispasmodic; it is applied externally, over bruised and rheumatic parts, and enlarged glands.

III. Sassafras officinale.—*Part used:*

1. Sassafras radix.

   Used as a stimulant and sudorific in syphilitic skin diseases and rheumatism; contained in Decoctum sarsæ compositum.

IV. Nectandra Rodiæi. *Part used:*

1. Nectandræ cortex. Bebeera bark.

   Used as a tonic and antispasmodic.
2. Berberiæ sulphas. *D.* 1–10 grs.

   Used as above.

Aristolochiaceæ.

I. Aristolochia serpentaria.—*Part used:*

1. Serpentariæ radix.
   - *a.* Infusum serpentariæ. *D.* 1–2 oz.
   - *b.* Tinctura serpentariæ. *D.* 1–2 drs.

   Used as a tonic and diaphoretic.

Thymelaceæ.

I. Daphne mezereum (spurge laurel).—*Part used:*

1. Mezerei cortex.
   - *a.* Extractum mezerei æthereum.

   Used as a local irritant, emetic, purgative, and diaphoretic in rheumatism and syphilis.

EUPHORBIACEÆ. *The Spurge Family.*

Male ♂, 3. 0. 1–12. 0. Female, ♀, 3. 0. 0. 2.

Herbs, shrubs, or trees.—Stems with acrid juice; leaves often bristly; flowers diclinous—*i.e.*, only one kind of essential organs are present. Sepals in both plants polysepalous. Petals wanting. Stamens in male flower vary from one to twelve in number. Ovary in female flower many-celled and many-seeded. Seeds, albuminous. Fruit, a capsule. Habitat, generally distributed.

Properties.—Acrid, tonic, aromatic, vesicant, purgative.

I. Croton eluteria.—*Part used:*

1. Cascarillæ cortex (bark). *D.* 10–30 grs.
   - *a.* Infusum cascarillæ. *D.* 1–2 oz.
   - *b.* Tinctura cascarillæ. *D.* ½–2 drs.

II. Croton tiglium. Croton oil plant.

1. Oleum crotonis. From the seed. *D.* ⅓–1 min. The seeds are oval, about six lines long and three broad, pale grey, mottled, with dark spots and lines. Seeds are inodorous; taste, at first mild and oleaginous, becomes acrid and burning.
   - *a.* Linimentum crotonis. (1 in 8.) Croton oil, oil of cajeput, and spirit.

   Used as a local irritant and drastic purgative.

III. Ricinus communis.—*Part used:*

1. Ricini oleum (castor oil). From the seed. *D.* 1 dr. to 1 oz.

   Active principle.—An alkaloid, ricinia, and palmitic and ricinoleic acids.

   The fruit is a prickly capsule with one seed in each cell. The seeds are oval, ⅓ inch in length, ¼ inch in breadth, and $\frac{1}{10}$ inch thick; pale grey externally, with darker spots and stripes, rendering them marbled.

   Used as a mild purge.

IV. Rottlera tinctoria.—*Part used:*

1. Kamala. The powder adhering to capsules. *D.* 30–120 grs.

   Used as an anthelmintic and purgative in tapeworm.

PIPERACEÆ.

I. Piper nigrum (black pepper).—*Part used:*

1. Piper nigrum. Unripe fruit. *D.* 5–20 grs. The fruit is black, wrinkled, and about the size of a small pea. No tail.

Active principle.—Piperin.

a. Confectio piperis. *D.* 60–120 grs.

Used as a stimulant and stomachic in dyspepsia, flatulence, diarrhœa, and as a stimulant to the Rectum.

II. Piper longum.—*Part used:*

1. Piper longum. Unripe fruit, about $1\frac{1}{2}$ inch long. *Used* as black pepper.

III. Cubeba officinalis. *Parts used:*

1. Cubeba (cubebs). Unripe fruit. *D.* 32–120 grs. Like black pepper, but possessing a stalk.
   a. Tinctura cubebæ. *D.* $\frac{1}{2}$–2 drs.
2. Oleum cubebæ, from cubebs. *D.* 5–20 mins. *Used* to stimulate the mucous membrane of the bladder and urethra.

IV. Artanthe elongata.—*Part used:*

1. Maticæ folia. *D.* 30–60 grs.
   a. Infusum maticæ. *D.* 1–4 oz.
   Used as a styptic and astringent.

LIQUIDAMBARACEÆ.

I. Liquidambar orientale.—*Part used:*

1. Styrax præparatus (storax). *D.* 5–20 grs. A resin from the inner bark; occurs as a greyish-brown thick opaque fluid.
   Used as balsam of Peru and Tolu.

ULMACEÆ.

I. Ulmus campestris.—*Part used:*
Ulmi cortex (the dried inner bark).
a. Decoctum ulmi. *D.* 2–4 oz.
Used as a demulcent and tonic in skin diseases.

CUPULIFERÆ. *Oak Family.*

Trees or shrubs. Leaves, alternate; flowers, monœcious—*i.e.*, male and female flowers distinct, but still on same plant; fruit, a glans or nut (acorn). Habitat, temperate climates.

Properties.—Astringent.

I. Quercus robur.—*Part used:*

1. Quercus cortex. Oak bark.
   a. Decoctum quercus. *D.* 1–3 oz.
   Used as an astringent in sore throat, &c.

II. Quercus infectoriæ.—*Part used:*

1. Galla. Galls are excrescences on the twigs, caused by the punctures and deposited ova of Diplolepis gallæ tinctoriæ. These excrescences

are produced by the female, which pierces the tender parts of the tree, and deposits her ova. The irritation determines secretion, and an enlargement occurs. The ova become larvæ, and the perfect insect is produced. The young tissues around serve for the nutrition of the young animal; and by-and-by, when all food is gone, it bores a hole and escapes. Galls are useless when this hole is seen. Galls vary in colour, but the blue and green galls are the best.

Active principles.—Tannic and gallic acid.

a. Unguentum gallæ.
b. Tinctura gallæ. *D.* $\frac{1}{2}$–2 drs.
c. Unguentum gallæ cum opio (*see* Opium).

Used as an astringent in hæmorrhage, and externally in piles.

2. Acidum tannicum. *D.* 2–10 grs. Made from galls, by powdering the galls, exposing the powder to a damp atmosphere, macerating with ether, partially evaporating, and drying. Occurs as yellowish-white glistening scales.
   a. Glycerinum acidi tannici (1 in 4).
   b. Trochisci acidi tannici ($\frac{1}{2}$ gr. in each).
   c. Suppositoria acidi tannici (3 grs. in each).
   d. Suppositoria acidi tannici cum sapone (3 grs. in each).

Used as an astringent in hæmorrhage and in dysentery.

3. Acidum gallicum. *D.* 2–10 grs. Made by moistening galls with water, and allowing fermentation to take place; boil with water, strain, crystallize, and purify by re-crystallization. Occurs as fawn coloured silky crystals.
   a. Glycerinum acidi gallici (1 in 4).

Used as tannic acid.

URTICACEÆ OR CANNABINACEÆ. *The Hemp Order.*

I. Cannabis sativa (Indian hemp).—*Part used:*

1. Cannabis indica (the flowering tops).
   a. Extractum cannabis indicæ. *D.* $\frac{1}{4}$–1 gr.
   b. Tinctura cannabis indicæ. *D.* 5–20 mins.

Used as a soporific, anodyne, and antispasmodic in neuralgia and bronchial spasms. It is used by natives of India for the purpose of intoxication, causing exhilaration of spirits.

II. Humulus lupulus (hops).—*Part used:*

1. Lupulus (the dried strobiles of the female plant).

Active principle, lupuline.

a. Tinctura lupuli. *D.* $\frac{1}{2}$–2 drs.

b. Extractum lupuli. *D.* 5–15 grs.

c. Infusum lupuli. *D.* 1–2 oz.

Used as a tonic stomachic and slight narcotic.

GYMNOSPERMIA.

Exogenic plants with naked ovules and seeds, the carpels constituting the scaly appendages found in the cones of the fir, &c. Instead of surrounding the ovules to form an ovary, they have the ovules at their axils. Ovules are fertilized by the direct application of the pollen.

Coniferæ.—*The Pine Family.*

Trees or shrubs. Stems with resinous juice. Leaves, needle-shaped, evergreen. Flowers, monœcious—*i.e.*, having separate male and female flowers on the same plant, or, diœcious—*i.e.*, having the male and female flowers on different plants. Female flowers are in cones. Ovules, two or more on the surface of each carpel near its attachment. Fruit, a cone—*i.e.*, a multiple fruit, or one formed by more than one flower. It consists of a number of carpels in the form of scales, with seeds in their axils. The galbulus is a rounded and flattened cone found in the juniper and cypress.

I. Pinus palustris, P. tæda, P. pinaster.—*Parts used:*

1. Terebinthinæ oleum (oil of turpentine). *D.* 10–30 mins., as a stimulant; 2–4 drs., as a purgative. An oil obtained from the resinous exudation by distillation.

a. Unguentum terebinthinæ.

b. Linimentum terebinthinæ.

c. Linimentum terebinthinæ aceticum.

d. Confectio terebinthinæ. *D.* 60–120 grs.

e. Enema terebinthinæ. Turpentine, 1; mucilage of starch, 15.

2. Resina, a residue of distillation in the preparation of the oil from resinous exudation.

a. Unguentum resinæ.

b. Emplastrum resinæ.

Used as an anthelmintic and purgative. In small doses it is useful in intestinal hæmorrhage, acting

as an astringent; it acts also as a diuretic, and communicates a violet colour to the urine.

Externally turpentine acts as a stimulant, and is used in making plasters.

III. Abies balsamea.—*Part used:*

1. Terebinthina canadensis. *D.* 20–30 grs. Canada balsam. A resinous exudation obtained by incision.

Used like other turpentines, and in making blistering paper and flexile collodium.

IV. Larix europæa (larch).—*Part used:*

1. Laricis cortex (larch bark).

Used as a stimulant, astringent, and expectorant.

V. Abies excelsa.—*Part used:*

1. Pix burgundica (Burgundy pitch). A resinous exudation.

a. Emplastrum picis.

Used as a stimulant and rubefacient in plasters.

VI. Pinus silvestris.—*Part used:*

1. Pix liquida (tar). *D.* 20–60 mins. Obtained from the wood of stems and roots by destructive distillation.

a. Unguentum picis liquidæ.

Used as a stimulant and alterative in skin disease and bronchitis.

VII. Juniperus communis.—*Part used:*

1. Juniperi oleum (oil of juniper). Obtained from unripe fruit by distillation.

a. Spiritus juniperi. *D.* $\frac{1}{2}$–1 dr.

Used as a stimulant and diuretic in dropsy.

VIII. Juniperus sabina.—*Part used:*

1. Sabinæ cacumina (savin tops).

a. Unguentum sabinæ.

b. Tinctura sabinæ. *D.* $\frac{1}{2}$–1 dr.

2. Oleum sabinæ. *D.* 1–5 mins. Obtained from savin tops by distillation.

Used as an emmenagogue in uterine diseases, and applied as an irritant externally.

CLASS II. ENDOGENÆ.

Flowering plants, possessing a stem, consisting of parenchyma, which contains fibro-vascular bundles and is surrounded by a rind. Leaves, parallel-veined.

Flower with following typical symmetry, 3. 3. 6. 3. One cotyledon only in the embryo. The radicle of the embryo undeveloped; the roots are adventitious.

Sub-Class I. Spadicifloræ.

The axis supporting the flower is thick and fleshy, and is termed a spadix. The flowers are sessile—*i.e.*, without stalks, and of the indefinite infloresence. A spathe—*i.e.*, a large coloured bract, usually surrounds the spadix.

Palmaceæ.

I. Areca catechu (the areca nut).
Used as an astringent. *D.* 15–30 grs.; and as an anthelmintic. *D.* $\frac{1}{2}$–$\frac{3}{4}$ oz.

Sub-Class II. Petaloideæ.

Sepals and petals both present. The petals are sometimes green like the sepals or may be coloured.

Zingiberaceæ.—*The Ginger Family.*

I. Zingiber officinale.—*Part used:*
1. Zingiber (ginger). The rhizome. *D.* 10–20 grs.
a. Tinctura zingiberis. (1 in 8.) *D.* 15–60 min.
b. Tinctura zingiberis fortior. (1 in 2.) *D.* 5–20 min.
c. Syrupus zingiberis. *D.* $\frac{1}{2}$–1 drs.
Used as a stimulant, carminative, &c.

II. Eletaria cardamomum.—*Part used:*
1. Cardamomum. The seeds. *D.* 5–20 grs.
a. Tinctura cardamomi composita (1 in 80). *D.* $\frac{1}{2}$–2 drs. Cardamoms, caraway, raisins, cinnamon, cochineal and proof spirit.
Used as an aromatic and stomachic, and as an adjunct to purgatives.

Smilaceæ.

I. Smilax officinalis.—*Part used:*
1. Sarsæ radix. Root of Jamaica sarsaparilla.
a. Decoctum sarsæ. (1 in 8.) *D.* 2–10 oz.
b. Decoctum sarsæ compositum. (1 in 8.) *D.* 2–10 oz. Sarsaparilla, $2\frac{1}{2}$ oz.; sassafras, $\frac{1}{4}$; guaiac wood, $\frac{1}{4}$; liquorice, $\frac{1}{4}$; mezereon, 60 grs., and water 20 oz.
c. Extractum sarsæ liquidum. *D.* 2–4 drs.
Used as an alterative and tonic in syphilis, gout, and skin diseases.

LILIACEÆ. 3. 3. 6. 3.—*The Lily Family.*

Herbs.—Leaves, sessile and sheathing. Flowers, regular; sepals, three, coloured; petals, three, coloured: both coloured yellow in the lily. Anthers, six, with their face towards the pistil—*i.e.*, introrse. Styles, combined to form one. Fruit, a capsule. Seeds, albuminous. Habitat, generally distributed.

Properties.—Stimulant, expectorant, diaphoretic, and purgative.

I. Urginea scilla.—*Part used:*

1. Scillæ (squill the dried bulb). *D.* 1–3 grs.
   - *a.* Tinctura scillæ. (1 in 8.) *D.* 10–20 mins.
   - *b.* Pilula scillæ composita. (1 in 5.) *D.* 5–10 grs. Squills, 5; ginger, 4; ammoniacum, 4; hard soap, 4; treacle 10.
   - *c.* Pilula ipecacuanhæ cum scilla. *D.* 5–10 grs. (*see* Ipecacuanha).
   - *d.* Acetum scillæ. *D.* 15–40 mins. Squill, dilute acetic acid, spirit.

     Hence:
   - *e.* Oxymel scillæ. *D.* ½–1 dr. Vinegar of squill and honey.
   - *f.* Syrupus scillæ. *D.* ½–1 dr. Vinegar of squill and sugar.

   Used as an expectorant in bronchitis, and as a diuretic in dropsy.

II. Aloe vulgaris.—*Part used:*

1. Aloe barbadensis. *D.* 2–6 grs. The inspissated juice of the leaves. Occurs in gourds. It is of a dull yellowish brown colour; it breaks with a dull conchoidal fracture; with a disagreeable odour when breathed upon, and a bitter taste.

   Active principle, barbaloin.
   - *a.* Extractum aloes barbadensis. *D.* 2–6 grs.
   - *b.* Pilula aloes barbadensis. (1 in 2.) *D.* 5–10 grs.
   - *c.* Pilula aloes et ferri. (1 in 6.) *D.* 5–10 grs. Aloes, sulphate of iron, comp. powder of cinnamon, and confection of roses.

1. Aloe socotrina (socotrine aloes). *D.* 2–6 grs. The juice of the leaves. Occurs in reddish brown masses, with resinous fracture, has an agreeable odour and bitter taste.

   Active principle, socaloin.

a. Tinctura aloes. (1 in 40.) *D.* 1–3 drs.
b. Vinum aloes. *D.* 1–2 drs. Aloes, cardamoms, and ginger—in sherry.
c. Pilula aloes socotrinæ. (1 in 2.) *D.* 5–10 grs.
d. Pilula aloes et assafœtidæ (*see* Assafœtida).
e. Pilula aloes et myrrhæ (*see* Myrrha).
f. Extractum aloes socotrinæ. *D.* 2–6 grs.
Hence:
g. Decoctum aloes compositum. (4 grs. in 1 oz.) *D.* 1–2 oz. Myrrh, saffron, carbonate of potash, extract of liquorice, comp. tincture of cardamoms, water, and extract of socotrine aloes.
h. Enema aloes. Made from either form of aloes. Aloes, 40 grs.; carbonate of potash, 15 grs.; mucilage of starch, 10 oz.
Used as a purgative and emmenagogue in dyspepsia, constipation, and amenorrhœa.

MELANTHACEÆ. 3. 3. 6. 3.—*Colchicum Family.*

Herbs.—Underground stems consisting of corms and bulbs. Sepals, three; petals three, both are more or less free. Anthers, extrorse—*i.e.*, with their faces turned outwards towards the petals, and their back or midrib towards the pistil, the reverse of Liliaceæ. Fruit, a capsule; seeds, albuminous. Habitat, generally distributed.

Properties.—Purgative and irritant.

I. Veratrum viride.—*Part used:*
Veratri viridis radix (green hellebore root). The rhizome. *D.* 1–3 grs.
a. Tinctura veratri viridis. *D.* 5–20 mins.
Used as an external irritant in skin diseases (*see* Veratria).

II. Asagræa officinalis.—*Part used:*
1. Sabadilla—the fruit.
From hence is obtained:
2. Veratria, an alkaloid. Exists as a dry white powder.
a. Unguentum veratriæ.
Used as an irritant and emetic, and drastic purgative.

III. Colchicum autumnale.—*Part used:*
1. Colchici cormus (colchicum corm). *D.* 2–8 grs. Shaped like a chestnut, bright brown outside, white and firm inside.

a. Extractum colchici. *D.* ½–2 grs. A green extract.
b. Extractum colchici aceticum. *D.* ½–2 grs.
c. Vinum colchici (1 in 5). *D.* 10–30 mins.

2. Colchici semina (colchicum seed). About the size of mustard seed. Reddish brown outside, white inside.
   a. Tinctura colchici seminum (1 in 8). *D.* 10–30 mins.
   Used in gout, rheumatism, dropsy, and skin diseases. It increases the secretion of the liver and kidneys, and quiets the heart's action.

Sub-Class III. Glumiferæ.

Monocotyledonous plants with flowers in spikelets. From within outwards, the parts seen in the flower are the pistils; stamens; lodiculæ (corolla); paleæ (calyx); and glumes (bracts). Leaves, linear, with large sheaths enclosing the stem.

GRAMINACEÆ. $\widehat{2+1}$. 2. 3. 1.—*The Grass Family.*

Herbs.—Stems, round, hollow, jointed. Leaves, alternate, with a large split sheath; in the axil of each leaf a rudimentary leaf-like body is found, called a ligule; it is supposed to be composed of stipules. The flowers are composed of the parts detailed under Glumiferæ—namely, from within outwards, pistils, stamens, lodiculæ (corolla), paleæ (calyx), and glumes (bracts). The corolla and calyx exist in the form of scales. Stamens, hypogynous—*i.e.*, inserted below the ovary. Ovary, superior—*i.e.*, above and distinct from the outer whorls. Fruit, a caryopsis—*i.e.*, a syncarpous, superior, indehiscent fruit with a dry pericarp. Seeds, albuminous. Habitat, generally distributed.

Properties.—Nutritive, demulcent. Ergot has a specific action on vessel walls and the muscular tissue of the uterus.

I. Triticum vulgare.—*Part used:*
1. Farina tritici (wheaten flour).
   Used in making pills and poultices.
   a. Mica panis (crumb of bread).
   b. Amylum (starch). Made by kneading and washing flour (*see* Sugar, &c.).
   Hence:

c. Glycerinum amyli (1 in 8).
d. Mucilago amyli (1 in 35.)
Used chiefly as demulcents and vehicles.

II. Hordeum distichon.—*Part used :*
1. Hordeum decorticatum (pearl barley).
a. Decoctum hordei (1 in 15). *D. ad lib.*
Used as a demulcent drink.

III. Secale cereale (common rye).—*Part used :*
1. Ergota (ergot). *D.* 20–30 grs. Ergot is a disease of the grain, due to a fungus, the Claviceps purpurea; the sclerotium, that is, the compact mycelium or spawn of the fungus, is produced within the paleæ of the rye, and gathered just before obtaining maturity. Active principles, ergotine, ecboline and fixed oil. Ergot occurs in firm, horny grains, about $\frac{1}{4}$ in. long, brown in colour externally, pinkish white inside:
a. Tinctura ergotæ (1 in 4). *D.* 10 mins. 1 dr.
b. Infusum ergotæ (1 in 40). *D.* 1–2 oz.
c. Extractum ergotæ liquidum. (1 in 1.) *D.* $\frac{1}{2}$–1dr. Made by removing oil by ether, digesting in water and adding spirit.

Used in hæmorrhage, owing to its action on the muscular walls of the smaller blood-vessels, causing them to contract. In parturition it is universally used to stimulate the muscular walls of the uterus to contract.

IV. Saccharum officinarum.—*Part used :*
1. Saccharum purificatum (refined sugar).
2. Theriaca (treacle)—(*see* Sugar).

SUB-KINGDOM. II. CRYPTOGAMIA

(flowerless Plants).

CLASS III. ACOTYLEDONES.

Plants with no embryo and no seed lobes; they grow by spores—that is, from a mass of simple cells with no distinction of parts. Stems and leaves, in some classes undistinguishable. Stems grow only at the summit; flowers are imperfect. They are divided into two classes, according to the character of the stem and leaf.

Sub-Class I. Acrogenæ.

Acotyledonous, flowerless plants, characterized by possessing distinct stems and leaves, distinguishable one from the other. Stomata exist over the plant.

Order, FILICES (ferns).

Herbs with an underground stem or with an ærial stem, as the tree fern. Leaves or fronds, simple or compound. The venation, or the arrangement of the ribs or veins of the leaf, is peculiar, being forked. Fructification takes place by spores covered by sporangia; these are small membranous sacs found usually on the lower surface of the leaf. The sporangia are frequently collected into small groups termed sori, which frequently have a protective covering called an indusium,

I. Aspidium filix-mas.—*Part used* :

1. Filix (fern root). *D.* 60–180 grs.

a. Extractum filicis liquidum, syn. oil of male fern. (4 in 10.) *D.* $\frac{1}{2}$–2 drs. Made with ether.

Active principles.—Filicic acid, tannin, and fixed and volatile oils.

Used as an anthelmintic in tape worm.

Sub-Class II. Thallogenæ.

LICHENES.

I. Cetraria islandica.—*Part used* ;

1. Cetraria (Iceland moss).

a. Decoctum cetrariæ. *D.* 1–2 oz.

Used as a demulcent.

From another lichen, rocella, is obtained :—

Lacmus (litmus), a blue pigment.

ANIMAL KINGDOM.

Class—Mammalia.

PACHYDERMATA.

I. Sus scrofa (the hog).—*Part used* :

1. Adeps præparatus (internal fat, washed, liquefied, and strained).

a. Adeps benzoatus (benzoatus lard). 1 oz. lard with 10 grs. benzoin.

Contains olein and stearine.

Used as an emollient in poultices and applied to ulcers.

RODENTIA.

I. Castor fiber (the beaver).—*Part used:*
1. Castoreum (castor). The follicles of prepuce. *D.* 5–10 grs.
a. Tinctura castorei. *D.* ½–1 dr.
Used as an antispasmodic in hysteria.

RUMINANTIA.

I. Moschus moschiferus (musk deer).—*Part used:*
1. Moschus (musk). Follicles of prepuce. *D.* 5–10 grs.
Used as above.

II. Ovis aries (sheep).—*Part used:*
1. Sevum preparatum (suet). Fat round kidney.
Used in ointments, plasters, &c.

III. Bos taurus (cow).—*Part used:*
1. Lac (milk).
a. Saccharum lactis (sugar of milk). Made by evaporating whey, and crystallizing.
2. Fel bovinum purificatum (ox bile). *D.* 5–10 grs.
Preparation.—By immersion in spirit, and partial evaporation.
Used as a laxative and stomachic in form of pill.

IV. Pig, sheep, or calf.—*Parts used:*
1. Pepsina (pepsine). *D.* 2–5 grs. Made by drying and pulverizing the mucous membrane of the stomach.
Used as a stomachic and digestive.
2. Sapo animalis (curd soap). Animal fat, consisting chiefly of stearine.
Used in the making of pills, &c.

CETACEA.

I. Physeter macrocephalus (sperm whale).—*Part used:*
1. Cetaceum (spermaceti). A nearly pure cetine, separated by cooling and purification from the oil contained in the head.
a. Unguentum cetacei.
Used as an emollient.

Class—Aves.

I. Gallus banckiva. Variety, domesticus—(the common fowl).—*Part used:*
1. Albumen ovi (egg albumen).
2. Vitellus ovi (yolk of egg).

Class—Pisces.

I. Acipenser (the sturgeon).—*Part used :*

1. Isinglass. The swim bladder, dried and cut into pieces. Yields gelatin.
Used as a test for tannic acid.

II. Gadus morrhua (the cod).—*Part used :*

1. Oleum morrhuæ (cod liver oil). *D.* 1–8 drs. Made by boiling and exposing to the sun, slicing and draining fresh livers. Occurs, when quite pure, as an almost colourless oil, with a fishy odour and taste.
Used in phthisis, scrofula, rheumatism, and as a substance easy of digestion in case of loss of weight and condition.

Class—Insectæ.

Hymenoptera.

I. Apis mellifica (the common bee).—*Part used :*

1. Mel (honey). *Used* as a vehicle.
   a. Mel depuratum (clarified honey).
   b. Oxymel. (*See* acetic acid and squills.)
2. Cera flava (yellow wax).
3. Cera alba (white wax).
   a. Unguentum simplex. White wax, 2; prepared lard, 3; almond oil, 3.

Hemiptera.

I. Coccus cacti.—*Part used :*

1. Coccus (cochineal).
   a. Tinctura cocci. *D.* 30 mins. to $1\frac{1}{2}$ drs.
   Used as a rubefacient, irritant, and diuretic in inflammations, nervous affections, and urinary diseases.

Coleoptera.

I. Cantharis vesicatoria.—*Part used :*

1. Cantharis, Cantharides. Beetles, about $\frac{1}{2}$ to 1 inch long, with green wing sheaths. When powdered, it occurs as small particles, brown in colour, with shining green specks.
   a. Charta epispastica.
   b. Emplastrum cantharidis. Called also emplastrum lyttæ. Cantharides, 24; yellow wax, 15; prepared suet, 15; resin, 6; prepared lard, 12.

c. Emplastrum calefaciens (warm plaster).
d. Unguentum cantharidis.
e. Liquor epispasticus (blistering liquid).
f. Tinctura cantharidis. (1 in 80.) *D.* 5–20 mins.

Used externally as a rubefacient and irritant; and as diuretic in internal inflammations. The tincture is given in nervous and urinary disorders.

Class—Annelida.

I. Sanguisuga officinalis (the green leech).

II. Sanguisuga medicinalis (speckled leech). Body, 2 or 3 inches long, tapering to each end. Back, dark green, and spotted with black. The first variety has its belly greenish yellow in colour, and spotted black; the second has an olive green belly, not spotted. A leech abstracts from 1 to 4 drs. of blood.

ALKALOIDS.

The alkaloids are assumed to have a single, double, triple or more molecules of ammonia as their base. Their resemblance to alkali bodies has determined their name, alkali-like, or alkaloids. Many of the alkaloids can be artificially produced; these belong to the class Amides. Most of the alkaloids are *solid* bodies, but two or three are *fluid,* such as conia and nicotine.

Alkaloids contained in Opium.

I. Morphia or Morphine, $C_{17}H_{19}NO_3H_2O$.—Morphia is found in opium, combined with meconic acid, forming the meconate of morphia. The alkaloid morphia, by itself is inert, and is not used medicinally, and when morphia is spoken of, not the simple alkaloid, but its commonest salt the hydrochlorate is meant. The meconate of morphia is present in opium from 6 to 15 per cent., and the method of extraction of morphia and preparation of the hydrochlorate are given together. (*See* British Pharmacopœia).

Morphia, or morphine—*i.e.*, the pure alkaloid—is usually met with as a powder; but it naturally consists of brilliant colourless six-sided prisms. In cold water it is scarcely soluble, 1 part dissolving in 1,000; in boiling water, a small quantity more dissolves, 1 in 400. In cold

alcohol, morphia is soluble in the proportion of 1 in 40; but, in boiling alcohol, 1 in 30. Potash, soda, and ammonia also dissolve morphia.

Physiological Action.—In the frog, morphia has an action resembling strychnia. At first there is agitation, then tetanic spasms occur, and finally all reflex actions are paralyzed. Some animals withstand the action of morphia a long time, pigeons requiring 2 grs. to kill them, and rabbits requiring much more. In the higher mammals, morphia acts on the sensory tracts, both peripheral and central.

In medicine, morphia possesses the advantage over opium in that it is a more convenient form for administration, $\frac{1}{6}$ of a grain of morphia being equal to 1 grain of opium. Morphia is also less stimulant, and less convulsant; its diaphoretic action is less, and its anodyne action more decided. The baneful after-effects of taking opium preparations are not found to the same extent with morphia. Hence morphia is used chiefly as an anodyne and antispasmodic when the long continued use of an opiate is necessary, as in cancer patients. It also presents the advantage that, owing to the solubility of its salts, it can be administered hypodermically. This renders the action speedy, and prevents the upset of the stomach so common after taking opium in the ordinary way.

II. Codeia has a feeble hypnotic action, and leaves a less disagreeable effect on the system. 4 grs. of codeia equal 1 gr. of morphia.

III. Thebaia, called also paramorphia, has a convulsant action. It is more like strychnia in its action than opium. 2 grs. of thebaia equal $\frac{1}{30}$ gr. of strychnia.

IV. Narcotine has a bitter flavour, but is useless as a hypnotic. *D.* 5–20 grs.

As an artificial product we have:

Apomorphia.—Made by heating morphia with HCl. A white salt, becoming green when exposed. Acts as an emetic, whether given by the mouth—*D.* $\frac{1}{10}$–$\frac{1}{6}$ gr.; or hypodermically—*D.* $\frac{1}{20}$–$\frac{1}{10}$ gr. in water.

Quinia, or Quinine. $C_{20}H_{24}N_2O_2$.

Quinine exists in all cinchona barks, but in the *yellow* bark it is most plentiful. In the *red* bark, it is nearly equal in quantity to the cinchonia; but in the *pale* bark cinchonia is present in quantity, whereas quinia

can scarcely be found. Quinia does not exist free, but exists as a kinate, being combined with kinic acid.

Quinia exists as a white crystalline powder, inodorous, with an intensely bitter taste; it has an alkaline reaction. In regard to solubility, it requires 400 parts cold water, 200 parts boiling water, 60 parts ether, 24 parts olive oil, 2 parts alcohol, and 2 parts chloroform. Solutions of the alkalies, carbonate of ammonia, &c., also render quinia soluble. Quinia is not used in medicine except as the sulphate, which is known by the name of quinine.

QUINIÆ SULPHAS. $(C_{20}H_{24}N_2O_2)_2H_2SO_47H_2O$.—The sulphate of quinia, prepared from cinchona calisaya and cinchona lancifolia.

Preparation.—*See* British Pharmacopœia.

Sulphate of quinine, usually called quinine, occurs as filiform, silky, white crystals. It is inodorous; but with an intensely bitter taste. Not very soluble in water, but dissolves easily when a drop or two of sulphuric acid is added. Its solution possesses a peculiar blue appearance, termed fluoresence.

Physiological Action.—Quinine affects the blood, and probably the blood-vessels, through the vaso-motor system. It has the power of arresting the migration of white blood corpuscles in inflammation; it also prevents the red corpuscles giving up their oxygen, and so diminishing waste of tissue. It increases the frequency of the pulse and the arterial tension, when it is given in small doses, and diminishes them in large doses. It diminishes the excitability of the cord. Its specific action, however, is seen in ague, in which it acts both as a prophylactic, by being administered in large doses before the development of the expected attack of rigor and sweats, and as a curative agent.

When given in large doses, quininism is produced, characterized by giddiness, singing noises in the ear, headache, flashes of light, and nausea. In large doses, the symptoms of cerebral affection may be increased, and delirium and coma may ensue. Death seems to result from paralysis of the cardiac and respiratory centres. A scarlet rash has been noticed after the administration of quinine.

Quinidine or *Quinidia* has the same formula as quinia, and is isomeric with it. It differs a little in its solubility and tests. It exists in the bark of most of the cinchona trees.

Quinicine is obtained by heating quinia.

Quinodine is amorphous quinia.

Cinchonia, $C_{20}H_{24}N_2O$, is met with in all the cinchona barks, but is most plentiful in the pale bark. It occurs in four-sided, anhydrous, colourless crystals. It is inodorous, and of a somewhat bitter taste. Cinchonia being more soluble in alcohol, requiring only 30 parts of boiling alcohol, is crystallized out, whilst the quinine remains in solution. Cinchonia has never been transformed into quinine, although the formulæ of the two resemble each other so closely. It is not nearly so powerful a drug as quinia, but it forms salts, which are more soluble in water and alcohol, and are much used by some as medicine. It is much cheaper than quinia or quinine.

Cinchonidia has the same formula as cinchonia, and is isomerous with it. It is found with quinidine in the mass left after the extraction of quinia and cinchonia from the bark.

Cinchonicine is obtained from cinchonia by heat.

Various *acids* exist in cinchona bark:

I. Kinic or quinic acid. The chief base of the quinia combinations as they exist in the bark.

II. Cincho-tannic acid. This acid is the cause of the astringent action of cinchona, as compared with quinia and cinchonia.

III. Cincho-pulvic acid, or red cinchonic acid. Characterized by its red colour.

IV. Kinovic acid.

ATROPIA, OR ATROPINE. $C_{17}H_{23}NO_3$.

An alkaloid obtained from the root of Atropia belladonna. It exists in the leaves as well as in the roots, but it is not so readily extracted from them. It exists in the plant as a malate of atropia.

Preparation.—See British Pharmcopœia.

It exists as colourless acicular crystals. Sparingly soluble in water, more readily in alcohol and in ether. Its solution gives an alkaline reaction.

Physiological action.—Belladonna and atropia belong to the class of deliriant narcotics. In the same class we have hyoscyamus and stramonium as having similar but less powerful action. The most pronounced and useful actions of belladonna (and atropia) may be summarized by saying, that it depresses or paralyzes peripheral nervous

mechanisms—that is, the connections between terminal nerves and involuntary muscles or muscular structures, and terminal nerves and gland cells. For instance, the sphincter of the eye is paralyzed, and the pupil dilates, when a solution of the drug is applied to the surface of the eye or administered internally. Then, again, the inhibitory action of the vagus on the heart is paralyzed, and the sympathetic, uncontrolled, causes the heart to beat quickly and irregularly. The effect on gland-cells is most marked, as is evinced by the checking the secretions of the saliva, sweat, and milk.

The effect on the spinal cord is best seen in the frog, for when atropia is injected hypodermically, the animal remains motionless for hours, and then is seized with tetanic spasms.

Aconitia, or Aconitine. $C_{33}H_{43}NO_{12}$.

The alkaloid obtained from the root of Aconitum napellus. It exists, however, in all parts of the plant, and is there combined with aconitic acid.

Preparation.—*See* British Pharmacopeia.

It occurs as a white powder, soluble in 150 parts of cold, and 50 parts of hot water. It is more soluble in alcohol and ether.

Physiological Action.—The first effect produced by the eating aconite, or chewing the leaves, is tingling and numbness of the mouth and throat. Then there is warmth in the stomach, which may proceed to sickness. The feeling of warmth spreads over the body, followed also by numbing and tingling. The intellect usually remains sound, but there is paralysis of both the reflex and motor activity of the cord giving rise to total loss of muscular power. The heart's action is first slowed and then quickened, and the respiratory movements become slower and slower, and finally cease. Aconite is then a cardiac and motor depressant and paralyzer of the sensory nerves.

Digitalinum, or Digitaline.

An alkaloid prepared from the dried leaves of Digitalis purpurea.

Mode of Preparation.—*See* British Pharmacopœia.

It occurs in masses or in small white scales. It is inodorous and intensely bitter. Almost insoluble in water, but soluble in spirit.

Physiological Action.—Digitalis acts: (1) as a direct stimulant to the heart muscle, and (2) it increases the inhibitory action of the vagus—*i.e.*, diminishes the frequency of the systole, or in other words, lengthens the diastole, and thus empties the veins. (3) It stimulates the muscular coat of the arteries through the vaso-motor system, and thus increases their tension. The total effect of the action of digitalis is to strengthen the heart, fill the arteries, and empty the veins, in other words, to maintain the circulation in its most perfect state. When larger doses of digitalis are administered the tension of the arteries begins to fall, and it is believed that this commences in the vessels of the kidney. The result of this is, as it were, pressure of the whole circulation upon the vessels of the glomeruli, within the Malpighian bodies of the kidney—*i.e.*, an increased escape of the watery elements of the blood—*i.e.*, profuse diuresis. Digitalis is thus one of the most powerful diuretics and that, not through the secreting substance of the kidney, but by means of the circulation.

Strychnia, or Strychnine. $C_{21}H_{22}N_2O_2$.

This alkaloid exists, combined with lactic acid, in the seeds of strychnos (nux vomica).

Preparation.—*See* British Pharmacopœia.

Strychnia exist as a granular powder, or as crystals. The crystals are either four-sided prisms, or octahedra. It is inodorous, and has an intensely bitter taste. It is sparingly soluble in cold water, but soluble in 2,500 parts of boiling water. It is soluble in boiling rectified spirit, and in chloroform, and its solubility is increased when a few drops of hydrochloric acid are added to the solution. It yields in solution an alkaline reaction. It is insoluble in absolute alcohol, ether, and the caustic alkalies. The commonest salts it forms are sulphates, nitrates, and hydrochlorates; these are all soluble in water, and still more readily in the presence of free acid.

Physiological Action.—In the frog minute quantities cause spasm of all the voluntary muscles capable of being excited by peripheral irritation. After the head is removed, the effects still persist, showing that the spinal cord is affected. In warm-blooded animals the spasms are less evidently reflex, but more of a tonic character, and exist mostly in extensors. Death results from

asphyxia, by arrest in spasm of the respiratory muscles. The outlying ganglia of the sympathetic are excited, especially those of the heart and intestines. The arterial pressure is increased.

Brucia, or Brucine. $C_{23}H_{26}N_2O_4$.

An alkaloid found along with strychnia in Nux vomica seeds. It exists in false angostura bark alone. It is more soluble in water and in alcohol than strychnine. It strikes with nitric acid a bright red colour which distinguishes its presence. In nux vomica there is also found an acid, strychnic or igasuric acid, which exists in union with the alkaloids.

Conia, or Conine. $C_8H_{15}N$.

The alkaloid obtained from Conium maculatum. All parts of the plant contain it, but it is most plentiful in the fruit. It exists in combination with conic acid, and to set free the alkaloid the presence of an alkali is necessary ; hence it is that, in the vapour, solution of potash is added, and the smell characteristic of hemlock can then be recognized. It occurs as an oily liquid, of a yellow colour at first, but becoming colourless when redistilled.

Physiological Action.—Conia acts by affecting the motor nerves, and the effects of the action are known to commence first in the feet and spread upwards. When the nerves essential to the supply of the respiratory muscles are affected, death will ensue. The drug is used in medicine to produce its physiological effect, in violent spasmodic seizures, as epilepsy, chorea, cramp, tetanus, &c., and to lessen pain in cancer. Along with conia, there exists methyl conia, which complicates and renders uncertain the action of the alkaloid.

Nicotia, or Nicotine. $C_{10}H_{14}N_2$.

The alkaloid contained in Nicotiana tabacum. It exists as the malate and citrate of nicotina, in the leaves.

It is a *liquid* volatile alkaloid, which, when exposed to the air, turns yellow, then brown, and finally becomes solid by the absorption of oxygen.

It is soluble in alcohol, ether, and water.

Physiological Use.—Tobacco acts as a powerful depressant to the heart, lowering the blood pressure, often causing nausea and vomiting. Muscular relaxation follows its use. It is often used in asthma for that purpose.

EMETIA, OR EMETINE. $C_{30}H_{44}N_2O_8$.

This alkaloid is the active principle of Cephaëlis ipecacuanha, where it exists combined with cephaëlic acid.

Emetina is a pure white inodorous powder, soluble in warm water and in alcohol, but sparingly in ether or oil.

Physiological Action.—Ipecacuanha and emetina are emetics acting in two ways. First, by direct action on the mucous membrane of the stomach; and, secondly, on the vomiting centre in the medulla oblongata. $\frac{1}{16}$–$\frac{1}{8}$ of a grain of emetina, given by the mouth, causes vomiting; when used hypodermically, a *larger* dose is required.

PHYSOSTIGMIA, OR ESERIA. $C_{30}H_{21}N_3O_4$.

An alkaloid obtained from Calabar bean, the seed of Physostigma venenosum. It occurs as a colourless amorphous powder. It is soluble in water, and readily combines with potash, soda, or lime.

Physiological Action.—The action of this alkaloid is judged of from the effects of the administration of the bean itself, or of an extract of the bean.

Calabar bean induces paralysis of the motor tract in the spinal cord. At first, by extreme effort of will, the patient is able to move, but, after a time, he becomes powerless. The pupil of the eye becomes contracted, whether the drug be applied to the eye or administered internally. It is probably through acting on the sympathetic fibres that supply the radiating muscular fibres of the eye that the effect is produced. It first stimulates the vagus, causing the heart's action to become slower, and, finally, from exhaustion of the nerve, the heart action becomes feeble and irregular. The drug kills either by paralyzing the respiration (asphyxia), or by stopping the heart's action (syncope).

OTHER ALKALOIDS

of minor importance in medicine are :—

1. Capsicia, or capsicine. From capsicum.
2. Cissampelia, or cissampeline. From Cissampelos pareira. Identical with beberia.
3. Lobelina, or lobeline. From Lobelia inflata.
4. Nectandra (*see* Beberia).
5. Piperia, or piperine. From Piper nigrum.
6. Solania, or solanine. From Solanum dulcamara.
7. Sparteia, or sparteine. From Scoparii cacumina.

8. Theia, theine, or caffeine, $C_8H_{10}N_4O_2+H_2O$. This alkaloid occurs in tea, coffee, Paraguay tea, guarana, and the kola-nut and others. The common beverages—tea, coffee, cocoa, and chocolate—contain this alkaloid, united with different substances, giving the different flavours to each. The action of theia is doubtful. It arrests the consumption of tissue, and relieves fatigue, but in what way is not proved.

9. Veratria, or veratrine. This alkaloid exists, combined with gallic acid, in veratrum, cevadilla, and colchicum autumnale. It has a depressant action on the heart, and when applied to the nose causes intense sneezing. It acts as an irritant in over doses.

10. Beberia, or beberine. An alkaloid existing in the bark of Nectandra Rodiæi. It is identical with the alkaloid contained in pareira root. A second alkaloid, nectandra, is also found in beberia. Beberia is not given by itself, but as the sulphate. It was supposed to be allied to quinine, but it is only a bitter stomachic tonic.

11. Berberia, or berberine. This alkaloid exists in Jateorrhiza calumba. The colour of the wood is probably due to the yellow berberia. Podophyllin is said to contain the same alkaloid.

12. Daturia. From Datura stramonium. Probably identical with atropia.

13. Hyoscyamia. From Hyoscyamus niger. Probably identical with atropia.

THERAPEUTICS.

A classification of the drugs used in medicine is here given, arranged according to their action. An attempt only is here made to explain the principle of the therapeutic action in each class. Want of space prevents fuller details being given; and special works must be referred to for further information.

Channels by which medicines may be administered:

1. By the mouth.
2. By the rectum, in the form of enemata and suppositories.
3. By various local applications.
   a. To the conjunctiva, as eye waters, or collyria.
   b. To the nose as snuff—causing sneezing or discharge. The former are called sternutatories or ptarmics, and the latter errhines.

c. To the gums, as solid applications, masticatories; or as fluid applications, washes, or collutoria.
d. To the throat, as gargles.
e. To the bronchi, as inhalations, and fumigations.

4. By the urethra.
5. By the vagina, injections, pessaries, &c.
6. By the skin.
   a. The enepidermic method, by poultices, lotions, &c.
   b. The epidermic method, rubbing with ointments; sometimes called the iatraleptic method.
   c. The endermic method; first applying a blister, and then on the raw surface dusting whatever drug may be advised, such as strychnia, tartar emetic, &c.
7. By the cellular tissues, the hypodermic method.
8. By the serous tissues, as the injecting the sac of a hydrocele.
9. By the veins. This plan is dangerous, but the most rapid in taking effect.
10. By the transfusion of blood.

The actions of medicines are affected by various conditions;

1. Idiosyncrasy. Some individuals will tolerate a drug in quantities that might be poisonous to others.

2. Habit. Long-continued use of any one drug, such as opium, will accustom the individual to its action, so that enormous doses may be taken.

3. The period of administration. The action of most medicines depends on the readiness with which they are absorbed; and as the absorptive power of the intestines differs at different times, the period at which medicines are given, must affect their action, thus:—

A *saline purge* is best given in the morning, before breakfast, as the drug, having then a comparatively empty canal to act on, is thereby more readily absorbed, and in consequence acts quickly.

A *pill*, which contains its active principle wrapped up in a *resinoid substance*, is best given with meals as a dinner pill, or on an empty stomach at bedtime.

Acids should be given some time after meals, when they will then help the gastric juice to finish off delayed digestion.

Alkalies should be given some time before meals as they stimulate the flow of gastric juice.

An *acid* on the one hand, and an *alkali* on the other, *prevent* the flow of digestive fluids of the *same* reaction as themselves, but *stimulate* the flow of digestive fluids having a *different* reaction. Medicines having an *irritating* or a *lowering* effect should be given at meal times —*i.e.*, *arsenic*, *strychnia*, and the like.

Cod liver oil, being a fatty material, is best given when the lacteals are active—viz., *during digestion*. When a drug is given for the purpose of re-inducing some vagrant healthy action, such as sleep, menstruation, &c., it is best given at the time when such events are physiologically to be expected; thus opium is best given when sleep usually takes place, and emmenagogues when the menstrual flow would naturally occur.

Anthelmintics, again, are best given after a considerable fast.

4. Age. Children, adults, and the aged are differently affected by drugs, and that, too, by what might be called an *idiosyncrasy of age*, as difference in years alone cannot explain many of the peculiarities. A child will stand as much of some drugs as will an adult, whilst the administration of other drugs, in even proportionately small quantities, will have deleterious effects. A scale of the quantities of drugs is here given as they may be proportionately administered to adults and children. Taking twenty to sixty as the period for exhibiting the maximum dose, and calling the quantity to be then administered 1, the proportions would then be :—

Under 1 year,	$\frac{1}{12}$	Under 4 years,	$\frac{1}{4}$	Under 20 years,	$\frac{2}{3}$
„ 2 „	$\frac{1}{8}$	„ 7 „	$\frac{1}{3}$	Over 20 „	1
„ 3 „	$\frac{1}{6}$	„ 14 „	$\frac{1}{2}$		

In regard to the quantities of drugs to be used according to the channel by which they are given, the following table has been drawn up. Taking the quantity given by the mouth as 1 : then by the rectum, the proportion given would be 2–3; by inunction, 3–6; by the endermic method, 1–3 ; by an ulcer, 2–4 ; by the hypodermic method, $\frac{1}{4}$.

Alteratives.

Medicines which, as the name implies, change nutrition, restoring it to a healthy state. There is no violent effect, such as purgation, but a gradual imperceptible action. For the perfecting of nutrition, not only the gastric juice,

but all the ferments in the body, must be in a healthy state. The activity of every digestive fluid in the body depends on a ferment, and were a ferment in an abnormal state, alteratives might either restore it to a healthy condition, or, by preventing its action on the tissues, lessen the effects of its mal-nutrition, until such times as a healthy state of the ferment was obtained.

The Alteratives and their Uses.

1. Nitric and nitro-hydrochloric acids; 2, mercurials; 3, taraxacum; 4, sulphur—are given in cases of digestive upset, whether from gastric catarrh, biliousness, or piles. 5, Phosphorus; 6, arsenic; 7, antimony—are used in nervous debility and nervous diseases, and in skin diseases. 8, Potash; 9, colchicum—are said to act on the muscles and joints in gout. 10, Iodine and iodides; 11, chlorine and chlorides; 12, hypophosphites—act on the lymphatic system, and are used to dispel strumous and syphilitic enlargements.

To absorb new deposits, and in primary and secondary syphilis, mercury and the iodides are largely used.

Anaphrodisiacs

Are the means by which sexual passion is diminished. The means and their action are: 1, cold water and ice—through action on the sensory nerves of the organs. 2. Bromide of potassium; 3, bromide of ammonium; 4, conium; 5, camphor—by acting on the genital centre, in the lumbar region of the spinal cord, cause the inhibition of the nerves supplying the arteries. 6. Digitalis—by direct action on the vessel wall, diminishes the blood supply; 7, moral surroundings; 8, the abiding by strict hygienic laws; 9, active pursuits, and the self-denial of all luxuries, serve as adjuncts to the medicinal treatment.

Anæsthetics

Are the drugs and means used to produce insensibility to pain. They are divided into two classes, local and general.

I. Local.—1. Ether spray—by producing rapid evaporation, and thereby freezing the skin. 2. Ice and salt has the same effect. These plans are painful both in the application and the thawing, but are useful in tapping the chest or abdomen, opening abscesses, &c.

II. General anæsthesia is produced by inhaling a gas with specific anæsthetic properties.

The gases in use are:

1. Nitrous Oxide, or Laughing Gas.—It is not advisable to use this gas in cases in which it is wished to keep up anæsthesia for more than a few minutes. No harm can come from this gas, not even from pushing it to excess, when commencing to administer it. The patient is known to be fully under its influence when the breathing becomes stertorous or interrupted, or when the pulse at the wrist becomes feeble.

2. Ether.—The best is the ether purus, B.P. Ether is administered either in a special apparatus manufactured for the purpose, or on a towel, sponge, or cone. About 1 oz. is placed on the inhaler at a time. Ether acts better when it is warmed, by placing the bottle that contains it in warm water. Ether can be given almost pure to begin with. Instead of using an enormous quantity at first, the best plan is to use a small quantity, but exclude the air. Nitrous oxide gas and ether are frequently administered together.

3. Chloroform must be administered slowly; and eight minutes ought to be allowed for the process. The patient should have been under observation for some time before, and it is not wise to administer chloroform in all cases haphazard. The administration of chloroform soon after a full meal is dangerous; so again the depression from long fasting, as frequently happens from an operation being put off for six or ten hours after the time the patient was prepared for it. If during this interval the patient has no food, death may ensue from the giving of chloroform.

Alcoholic patients are the most dangerous class to give chloroform to.

To *give* chloroform, a drachm of chloroform should be placed on a small piece of lint tightly rolled, held over the mouth by the hand, and the whole covered over by a towel. Not more than 15 or 30 minims should be poured on the lint at a time after the first start. The towel should not be removed, when the hand is withdrawn for a fresh supply, unless alarming symptoms occur.

After the first few whiffs of chloroform the patient becomes excited, and laughs and talks in a semi-conscious manner. As the administration proceeds the talking gets

more incoherent, and the patient tosses about to get rid of the suffocating, annoying sensation of the chloroform. The pulse is quickened, and the muscles are thrown into a state of spasm. Complete unconsciousness now intervenes, the breathing becomes shallow, the muscles become relaxed, and the pulse is slow and feeble.

Should chloroform be pushed beyond this, the patient is heard to breathe stertorously, the face becomes livid, the pulse flags, and the patient may die comatose.

Death may also occur from asphyxia. In this state no air enters or comes out during respiration, and the pulse stops. Cardiac syncope, after the first few inspirations, may occur, and death suddenly ensue. When alarming symptoms occur from an anæsthetic, cease administration, raise the chin, pull the tongue forcibly forward, and, if necessary, perform artificial respiration.

4. Bichloride of Methylene is an unsafe anæsthetic, from the variable amount of chloroform it contains.

Anodynes.

Medicines which relieve pain. Some drugs do so by acting on central organs, and some by acting on terminal nerve organs, which happen to be the seat of pain. Opium acts on all tracts of sensory nerve tissue, centres, cord, and nerve ends: belladonna acts on nerve ends chiefly; chloral, and the like, relieves the patient's pain by inducing sleep. Anodynes are: 1, Opium, and the alkaloids morphia and codeia; 2, bromide of potassium; 3, cannabis indica; 4, belladonna and atropia; 5, hyoscyamus; 6, stramonium; 7, conium; 8, camphor; 9, aconite and aconitia; 10, lupulus; 11, chloroform; 12, ether; 13, chloral hydrate; 14, butyl chloral hydrate; 15, gelseminum; 16, heat and moisture; 17, cold; 18, counter-irritation; 19, blood-letting; 20, position.

Antacids.

Drugs used to neutralize the acidity of the secretions. The gastric secretion is acted on directly by some, whilst the urinary secretion is acted on more remotely, by the drugs which have passed through the blood.

1. Ammonia and ammonium carbonate are direct antacids, only they are mostly excreted as urea.

2. Alkalies and the alkaline earths, with their car-

bonates, except ammonia, are antacids to the gastric secretion, and also lessen the acidity of urine.

3. Acetates, citrates, and alkaline tartrates act on the kidney secretion, lessening its acidity.

Anthelmintics.

Medicines which kill or get rid of intestinal worms. Vermicides kill the worms, and vermifuges expel them.

I. For tape worms: 1, Oil of male fern; 2 oil of turpentine; 3, kousso; 4, kamala; 5, areca nut.

II. For round worms: 1, worm seed; 2, santonin; 3, areca nut.

III. For thread worms: 1, worm seed; 2, santonin; 3, areca nut; 4, enemata—*a*, of quassia; *b*, salt and water; *c*, vinegar and water; *d*, chloride of iron; *e*, sulphate of iron; *f*, oil of turpentine; *g*, castor oil; *h*, decoction of aloes. Scammony, castor oil, jalap, &c., act only as vermifuges; tonics, such as iron, are required to give tone to intestines, and check excessive mucous secretion, after expulsion of the worms.

Antiperiodics.

Medicines which check the paroxysms of periodic diseases. How antiperiodics act is undetermined. Malarial, intermittent, and remittent fevers are the diseases in which they are most useful.

The drugs are: 1, Cinchona and its alkaloids; 2, bebeeru bark; 3, salicin; 4, arsenic.

Antipyretics.

Agents used to reduce the temperature of the body. Some drugs lessen the production of heat, others increase the abstraction.

The means used are: 1, cold baths; 2, ice; 3, quinine; 4, diaphoretics; 5, alcohol; 6, salicin and salicylic acids; 7, purgatives; 8, digitalis; 9, aconite.

Alcohol and diaphoretics cause the vessels of the skin to dilate, and so heat is allowed to radiate from the surface of the body quickly, thereby cooling it.

Antiseptics, Disinfectants, and Deodorants.

I. Antiseptics or Antiputrescents are substances used to prevent putrefaction. They act by killing the organisms of which the putrefactive ferment is composed. We can classify the agents as—

1. Gases: Chlorine, sulphur when burned giving off sulphurous dioxide or sulphurous acid gas, and nitric and nitrous oxide fumes.

2. Substances giving off vapours, and which can be recognized by their odour: Carbolic acid, creasote, chlorinated lime and chloride of lime, and tar.

3. Inodorous substances—*i.e.*, giving no vapour: Permanganate of potash (Condy's Fluid), chloride of zinc (Burnett's Fluid), charcoal, boracic acid, and chlorate of potash.

Used in the treatment of wounds; given internally in foul breath, cancer of intestine, in infectious fevers, and dilatation of the stomach.

II. Disinfectants are used to prevent the spread of infectious diseases. They are believed to do so by the power they have of preventing decomposition in any substance. Further, they naturally run into the class Antiseptics, from the fact that organisms are stayed in their action, and probably destroyed. In regard to their mode of action, some oxidize organic matter, others withdraw oxygen from organic compounds; still another class act by coagulating albumen, and such a substance as carbolic acid arrests molecular change and decomposition.

The disinfectants are—1, air; 2, water; 3, heat, either by boiling or baking clothing, or exposing clothing, carpets, blankets, curtains, &c., in hot brick chambers, to a temperature of 220° F.; 4, carbolic acid, should be used of the strength of 1 in 20—*i.e.*, 5 per cent.—when intended to be used to disinfect clothing. (McDougall's powder is a convenient means of using carbolic acid.) 5, Sulphur, as sulphurous acid gas; obtained by burning sulphur, or as a fluid, obtained by dissolving sulphurous acid in water, is the most potent and reliable of disinfectants. 6, Chlorine, as given off from chloride of lime when hydrochloric acid is poured over it. The fumes are highly disinfectant, owing likely to the affinity chlorine has for hydrogen.

7, Permanganate of potash, or, as it is generally found, Condy's Fluid, disinfects whatever it touches, as clothing, utensils, &c., but is useless as it is generally used, in saucers about the room. Condy's Fluid stains clothing. 8, Acids, such as the mineral acids, are powerful disinfectants, but impracticable. 9, Charcoal in poultices, or in powder. 10, Chloride of lime, or bleaching powder, gives off chlorine. 11, Chloride of zinc (Burnett's Fluid). 12, Sulphate of copper in solution. And many others, the action of which is more than doubtful.

III. Deodorants are substances which cover the odour of, or actually destroy, noxious gases. The deodorants in Nature are—Ozone, the odours of flowers, and the earth. Ozone oxidizes what it comes in contact with; the odours of flowers, uniting with oxygen, form peroxide of hydrogen; and the earth absorbs.

The deodorants in common use are:—*Gases:* 1, Chlorine, as given off from chlorinated lime, destroys noxious odours; 2, sulphurous acid gas; 3, nitrous oxide gas. *Absorbents:* 1, Charcoal; 2, lime; 3, permanganate of potash; 4, nitrate of lead; 5, sulphate of iron.

Antispasmodics.

Agents used to check spasms. Some nerve centres when excited produce muscular movements, others arrest them. According as one or other of these predominate, so will there be a disturbance of the muscular movements of any part.

Antispasmodics act by holding in abeyance the excessive discharge of nerve force from an over-excited nerve-centre.

The chief agents are:—1, Bromides of potassium and ammonium; 2, valerian; 3, assafœtida; 4, chloroform; 5, ether; 6, alcohol; 7, lobelia; 8, stramonium; 9, nitrite of amyl; 10, arsenic; 11, zinc; 12, copper; 13, conium; 14, camphor; 15, opium; 16, belladonna; 17, Indian hemp; 18, musk; 19, castor; 20, quinine. And such agencies as cold, friction, heat, and exercise.

Astringents

are the means by which contraction is induced in the tissues of the body.

Some astringents act directly on the parts to which they are applied, others acting by means of the blood, possess a remote action. They are :—1, Cold and ice; 2, nitrate of silver; 3, sulphate of copper; 4, sulphate of zinc; 5, alum; 6, perchloride of iron; these act for the most part locally. 7, acetate of lead; 8, tannic acid; 9, gallic acid; 10, kino; 11, catechu; 12, dilute mineral acids; these are given internally, and act through the blood or on the blood-vessels.

The manner of action of the above-mentioned differ; some, such as the mineral acids, precipitate albumen from alkaline fluids, but do not coagulate it; gallic acid again does neither; whilst all the others mentioned combine with the albuminous exudation of a raw surface, and with the actual tissue. Astringents are used to check excessive excretion from mucous surfaces, such as that of the eye, nose, mouth, throat, larynx, rectum, in diarrhœa, and to stop catarrh. Excessive granulations on ulcerated surfaces are checked by astringent applications, and tone given to wounds that flag in their healing.

Cold and Heat.

The extremes of cold and heat are productive of disease, and death of the individual, or of destruction of a part of the body surface. It is neither frost-bite, nor the charring from a burn we would here discuss, but the therapeutic action that we are to consider.

I. Cold can be applied as—

1. A cold bath may be either in the form of a sea, river, or sponge bath, or as a shower bath. The temperature of the cold bath ranges from 34°–55°; the cool bath from 65°–75°.

2. A cold affusion—the patient unclothed and seated in a bath, has as many gallons of water poured over him as is thought desirable.

3. A cold douche—a stream of cold water applied for some time on one part, say a weak knee.

4. A wet pack—by this is meant the wrapping of the patient in a sheet dipped in cold water, and superadding a covering of blankets to induce heat. The temperature rapidly falls, and has to be watched carefully. Forty minutes is the time usually allowed for application.

5. Ice, either in an india-rubber ice-bag, or bladder, or placed directly on the surface.

6. Cold compresses.

7. Irrigation—allowing cold water to drop on lint placed on the skin so as continually to keep it wet and cold; the part under the lint suffers a rapid abstraction of heat.

8. Lotions containing spirit or ammonia. These evaporate so rapidly that heat is carried off from the surface.

The first effect of cold is to cause shock to the skin and the body generally, inducing gasping respiration, a disturbance of the circulation, pallor of the skin, and the condition known as goose-skin. After this, provided a person be in ordinary health, reaction comes on, and the depression induced by the shock gives way to easy breathing, quickened circulation, a glow all over the surface of the body, and heightened spirits. From too long exposure, the reaction will in turn give way to shivering and depression, and a feeling of cold, which does not leave the patient for hours; and should this condition be induced frequently, the patient will get into a low, nervous, and anæmic state. The power of resisting cold depends on one's strength; a weak person going into a cold bath may never get a reaction, or again, the reaction may be transient; in both these cases much harm may be done, and cold bathing should be recommended with judgment. In all cases the cold bath should be discontinued during the stage of reaction.

II. Heat may be applied as :—

1. Hot-water baths, varying from water but slightly heated, up to as hot as can be borne.

Temperate baths	75°– 85°
Tepid baths	85°– 92°
Warm baths	92°– 98°
Hot baths	98°–110°

Water used hotter than this is dangerous, especially to children, inducing shock which may be fatal. Hot baths cause a flow of blood to the skin, relieving internal organs, allaying spasms, and soothing pain.

2. Hot-air baths may be administered by the patient walking into a chamber, the temperature of 117°, until perspiration occurs, then proceeding to a higher temperature of 140°. Should the patient be in bed, the hot air can be introduced beneath the blankets, carefully watching the temperature.

3. Vapour baths. In this bath the hot air is charged with steam. A heat of more than 122° is neither comfortable nor safe.

4. Poultices and fomentations, in which the heat and moisture is kept applied for some time. Fomentations should be changed every twenty minutes, poultices every three hours.

5. Dry heat. This can be applied either by hot flannels, hot tins, or hot sand, and is of use in severe colic, spasms, and collapse.

Medicinal Baths.

Simple liquid baths, hot air and vapour baths, are described under Cold and Heat. Of the medicinal baths some are liquid or vaporous, natural or artificial.

Artificial Baths are :—

A. *Liquid Baths.*

1. Sea-water baths, made by adding 9lbs. of salt (chloride of sodium) to 30 gallons of water.

2. Alkaline baths, made by adding 6 oz. of carbonate of soda, or 3 oz. of carbonate of potash, to 30 gallons of water.

3. Mustard baths, made by adding a handful of mustard to the ordinary hot water bath; or a tablespoonful of mustard to as much water as will cover a child.

4. Corrosive sublimate baths. To 30 gallons of water add 3 drachms of mercuric chloride, and 1 drachm of hydrochloric acid.

The less commonly used are :—

5. Bran baths.

6. Nitro-hydrochloric baths—1 oz. to 1 gallon of water.

7. Ozone baths.

B. *Medicinal, Vapour, and Air Baths.*

1. Mercurial vapour baths. To an ordinary vapour or hot air bath, administered in the usual way, the fumes of a mercurial salt are added, in the form of vapour. The salt used may be the red oxide, about 100 grains; or calomel, about 20 grains, placed in an open earthenware or tin vessel, and evaporated by means of a spirit lamp. Useful in syphilides.

2. Sulphurous acid baths. Instead of a mercurial salt

sulphur may be used, when sulphurous acid is generated. Useful in chronic skin affections.

Caustics and Escharotics

are the means employed to destroy living tissues. They are:—1, the actual cautery; 2, galvano-cautery; 3, caustic soda, potash and lime; 4, nitric, sulphuric, hydrochloric and glacial acetic acids; 5, chloride of antimony (butter of antimony); 6, chloride and sulphate of zinc (white vitriol); 7, mercuric oxide (red); 8, mercuric chloride; 9, carbolic acid in strong solution; 10, moxa; 11, nitrate of silver; 12, sulphate of copper; 13, arsenious acid; 14, alum, powdered. Escharotics are by some separated from caustic, but the two merely differ in degree of action, the former causing a slough.

Counter-Irritants

are substances used to allay the diseased condition in any part, by determining the circulation and the influence of the morbid condition to some adjacent healthy structure. Some counter-irritants act by reddening a large surface and are called rubefacients; others more active, cause a blister to be formed, and are called vesicants; whilst a few cause a pustular eruption on the skin.

Blisters is a general name for the class, and it is generally to produce a blister that counter-irritants are used.

I. Rubefacients are:—1, Hot water; 2, mustard poultices or mustard leaves, or any of the preparations of mustard, mustard poultices should be made with cold water, and not kept on longer than twenty minutes; 3, the liniment of ammonia; 4, oil of turpentine; 5, oil of cajuput.

II. Vesicants or blisters cause first a reddening of the skin, then a number of vesicles, which running together form a bleb, containing serous fluid.

1. Cantharis, Spanish fly. The blister should be kept on three or four hours, and if a vesicle is not then formed, a poultice (linseed meal) ought to be applied over it, or the blistering paper may be removed, and a poultice applied over the spot. When a bleb has been formed, prick the most dependent point with a needle, and dress the part with cotton wool. Strangury is one of the

dangers of fly blisters. To prevent such a condition, powder the part to be blistered with camphor, or interpose a thin piece of rice paper between the blister and the skin.

2. Glacial acetic acid is rapid in its action, but dangerous as it causes a slough.

3. Liquor ammoniæ produces rapid vesication.

4. The actual cautery.

5. Moxa. Cut a hole in the centre of a wet rag, and apply to the skin; in the hole place moxa—*i.e.*, cotton wool soaked in a solution of nitrate of potash, or the pith of the sunflower—and set it on fire. The lighted moxa burns down and forms an eschar. This application is very painful, and has almost gone out of use.

III. Pustulants.—Chief amongst these is croton oil, which first produces a papular and then a pustular eruption. Besides this drug we have antimonium tartaratum, which in the condition of a hot solution causes a pustular eruption.

IV. Issues.—Cut a hole in the centre of a piece of plaster and place it on the skin. In the hole, place a piece of caustic potash, and a raw surface will by-and-by be formed which can be made to discharge for any length of time. A pea used to be put into the hole to keep up irritation.

V. Setons.—Counter-irritation may be kept up by passing a few silk threads through or over an inflamed part. A couple of holes are made, say two or three inches apart, and a few threads passed through beneath the skin from one to the other.

Diaphoretics

are means by which the secretion of the sweat is increased. The administration of diaphoretics causes a determination of blood to the skin, and an activity of the sweat glands.

The more common diaphoretics are: 1, Vapour and hot-air baths; 2, wet pack; 3, warmth, either as drink or clothing; 4, antimony; 5, ipecacuanha; 6, opium, and its derivatives; 7, senega; 8, camphor; 9, sarsaparilla, and the ingredients of the compound decoction; 10, ammonia, and its salts; 11, alcohol; 12, ether.

In fevers, the skin is in a state of hyperæmia, but the glands are not active, consequently any diaphoretics will, by setting up their action, cause a pronounced reduction of

temperature, all the more marked that the skin is in an abnormally hyperæmic condition.

Diuretics

are means employed to increase the urinary secretion. They are: 1, Water, in quantity; 2, cold to the skin; 3, salts of the alkalies, especially the nitrate and citrate of potash, the tartrates of soda and potash, and the acetate of ammonia; 4, nitrous ether; 5, alcohol; 6, juniper; 7, digitalis; 8, scoparium; 9, turpentine; 10, cantharides—in too great quantity produces strangury; 11, squills; 12, copaiba.

The media through which diuretics act are: 1, The blood, increasing the pressure generally; 2, the renal arteries, on which digitalis has a specific action; 3, the renal nerves; 4, the cells of the kidney tubes, on which the salts of the alkalies have a directly-stimulating action. Purgatives help diuretics in their action.

Ecbolics

are substances used to cause contraction of the gravid uterus. They act either directly on the muscular substance, or through influencing the uterine centre in the spinal cord: 1, Ergot; 2, savin; 3, digitalis.

Emmenagogues

are closely allied to the preceding group in their method of action. They are given to restore the function of the uterus in the non-pregnant state: 1, Ergot; 2, savin; 3, digitalis; 4, quinine; 5, rue; 6, and all means used to improve the general health, removing anæmia, constipation, hysteria, &c.

Emetics

are the means employed to produce vomiting. They are: 1, Tepid water; 2, mustard and water; 3, common salt and water; 4, sulphate of zinc; 5, chamomile; 6, antimonium tartaratum (tartar emetic); 7, ipecacuanha; 8, sulphate of copper; 9, carbonate of ammonia; 10, tickling the fauces. The so-called direct emetics act on the nerves of the stomach only; indirect emetics, on the other hand, act through the medulla oblongata, and set up action in other organs; as, the salivary glands, skin, and respiratory tract.

Emetics are used to unload the stomach of undigested

food, or of a poison; to empty the bile ducts and gall bladder, and to cause sickness in cases of bronchial exudation, as in croup.

Expectorants

are medicines used to help the air passages to get rid of an excess of secretion or, as it is usually called, phlegm. They are: 1, Ipecacuanha; 2, ammonia and carbonate of ammonia; 3, squills; 4, senega; 5, antimony; 6, iodide of potassium; 7, benzoin and benzoic acid; 8, myrrh; 9, balsams of Tolu and Peru; 10, tar; 11, creasote; 12, nux vomica; 13, ammoniacum; 14, galbanum; 15, chloride of potassium; 16, chloride of ammonium; 17, inhalation of steam; 18, many others of lesser importance which act indirectly—anise, fennel, carbolic acid, strychnia, belladonna, tobacco, opium, vapours of chlorine and iodine.

Expectorants act in different ways. Some relieve congestion of the vessels in the mucous membrane, as ipecacuanha and antimony: others act as stimulants to the bronchial passages, such as squills, benzoin, &c. Medicines, such as ammonia, quicken the respiration and circulation, and so relieve the air-passages; opium, belladonna, stramonium, and drugs of that class relieve spasm. Emetics of all kinds are largely useful in clearing the respiratory tract.

Narcotics

are the drugs and means used to produce sleep. Although the effect of the means employed is the same, they act in many different ways. An anæmic condition of the cerebral hemispheres is supposed to be the condition requisite to obtain sleep, but opium contracts the vessels, whilst digitalis and chloral produce dilatation of the vessels of the brain. They are: 1, Opium; 2, bromide of potassium; 3, chloral; 4, digitalis; 5, alcohol, in small quantities; 6, hyoscyamus; 7, chloroform; 8, indirect means in enormous number, as quiet, warmth, a comfortable bed, sponging with water, bringing down the temperature, relieving pain, &c. &c.

Hypnotics.

See Narcotics.—The term narcotism has come to mean an advanced stage of hypnotism, referring rather to the poisonous effects of the drugs.

Purgatives.

In the list given below, one will find the same drug mentioned, it may be, *twice* or *thrice*. Thus jalap is mentioned three times; so that the arrangement is more or less artificial. The particular medicine given varies in its action according to the amount administered, and the substances with which it is combined. Some purgatives, again, act on the duodenum, as podophyllin; others on the small intestines, as senna; and others on the colon, as aloes. Saline purgatives are best given as fluid mixtures, and the best time for their administration is the early morning; whereas organic substances are best given as a pill at bedtime.

I. Laxatives.—Substances causing a slight increase in the action of the intestine: 1, Magnesia; 2, castor oil; 3, sulphur; 4, prunes and figs.

II. Simple Purgatives.—Substances causing a rapid and thorough evacuation of the bowel. 1, Rhubarb; 2, senna; 3, aloes; 4, jalap. For simple purgation these drugs should be given in moderate doses.

III. Drastic Purgatives.—This group includes many of the former when given in large doses. They act not only on the wall of the intestine, but also withdraw the water from the blood. 1, Jalap; 2, scammony; 3, colocynth; 4, gamboge; 5, croton oil.

IV. Hydragogue Purgatives are substances used to withdraw fluids from the blood of the intestines in dropsy, and to relieve venous congestion. 1, Elaterium; 2, acid tartrate of potash.

V. Cholagogue Purgatives are substances used to increase the secretion of bile, and at the same time produce purgation. 1, Podophyllin; 2, aloes; 3, jalap; 4, rhubarb; 5, colocynth; 6, calomel; 7, colchicum; 8, ipecacuanha; 9, sulphate of soda.

VI. Saline Purgatives.—The salts belonging to this group act by irritating the mucous membrane, absorbing and attracting fluid from the blood, which from its accumulation within the intestines give rise to a liquid stool. 1, Sulphate of magnesia (Epsom salts); 2, salts of soda; 3, salts of potash; 4, natural purgative waters.

Refrigerants.

See Anti-pyretics. The word refrigerant simply implies the relieving of thirst, and naturally includes all the anti-pyretics, and such other means as acid drinks, &c.

Sedatives

are divided into two classes :—

I. GENERAL SEDATIVES.—Muscular exhaustion and fatigue, heat and moisture, and narcotics used to procure sleep and relief from pain.

II. SPECIAL SEDATIVES :—

1. *Nervine.*—Opium in full doses, bromide of potassium, conium, Calabar bean, chloral, aconite, hydrocyanic acid, and belladonna. Some of these act on the cerebrum, as opium; others, as Calabar bean, on the cord ; and others again on the nerves and nerve endings, as belladonna.

2. *Vascular.*—Aconite, chloroform, antimonium tartaratum in full doses, chloral, and colchicum.

3. *Digestive.*—Bismuth, hydrocyanic acid, and the salts of the alkalies in small doses.

Stimulants

may be divided into two classes :—

I. GENERAL STIMULANTS.—1, Exercise; 2, food; 3, alcohol; 4, cold; 5, electricity.

II. SPECIAL STIMULANTS :—

1. *Nervine.*—Alcohol, ether, opium, phosphorus, digitalis, strychnia, and quinine.

2. *Vascular.*—The general stimulants above enumerated; along with digitalis, ergot, and belladonna, by increasing the arterial tension.

3. *Digestive.*—Stomachic stimulants are : Ginger, capsicum, pepper, &c. Stimulants to the flow of bile, *see* Cholagogues; to the kidneys, *see* Diuretics; to the intestines, *see* Purgatives ; to the skin, *see* Diaphoretics.

Tonics

are divided into :—

I. GENERAL TONICS.—1, Fresh air ; 2, exercise ; 3, cold water; 4, food; 5, alcohol; 6, change of scene; 7, and all the means by which the body is kept in health.

II. SPECIAL TONICS :—

1. *Nervine.*—Sleep, change of scene, and narcotics, given to allow of rest to the brain. Strychnia, quinine, arsenic, and oxide of zinc act by increasing the tension of the cord and nerves.

2. *Vascular.*—Digitalis ; ergot and belladonna ; iron, phosphorus, arsenic, cod liver oil. Digitalis acts on the heart ; ergot and belladonna act by increasing the

arterial tension, whilst the drugs of last group improve the condition of the blood itself.

3. *Digestive.*—Bitters, pepper, mustard, hydrocyanic acid and weak mineral acids, especially hydrochloric.

A FEW OF THE MORE COMMON MEASUREMENTS.

Used in the British Pharmacopœia.

1 grain, gr.	=	1 grain	=	0·0648 grammes.
1 ounce, oz.	=	437·5 grs.	=	28·3495 grammes.
1 pound, lb.	=	7000 grs.	=	453·5928 grammes.
1 pound, lb.	=	16 oz.		

1 gramme=weight of a cubic centimetre of water at 40°C.

1 cubic centimetre=15·432 grs.=1 gramme.

Measures of Capacity.

1 minim, ♏	=	min. j	=	0·91 grs. of water.
1 fluid drachm, ʒ	=	min. lx	=	54·68 ,,
1 fluid ounce, ℥	=	fl. drs. viij	=	437·5 ,,
1 pint, O	=	fl. oz. xx	=	8750·0 ,,
1 gallon, C	=	O viiij	=	70000·0 ,,

1 litre=1 pint 15 oz. 2 drs. 11 min.=1000 grammes of water=15432·348 grs. of water.

The symbols given above, ♏, ʒ, ℥, O, and C, are still used, and although easily written and remembered, are not so free of danger as written initial letters. The symbol ℈, signifying scruple, is not now much used.

Measures of Length.

1 line=$\frac{1}{12}$inch.

1 metre=39·37079 inches=1 yard 3·37 inches.

OFFICINAL FORMULÆ.

In this enumeration the numbers only of the different groups of formulæ are given, and only special and important preparations are noted. It will be a good exercise for the student to fill in the names of drugs under the various headings.

I. Aquæ, thirteen in number.

II. Cataplasmata, six.

III. Confectiones, eight. These serve as excipients for medicines and to give consistency to pill masses.

IV. Decocta, fourteen. Made by boiling the vegetable substances from which they are derived in water from 5 to 20 minutes.

V. Emplastra, fourteen. Plasters have litharge as their base, in combination with the fatty acids—oleic, margaric, and stearic acids. There are one or two exceptions to this rule, such as emplastrum cantharidis, and emplastrum picis.

VI. Enemata, six.

VII. Essentiæ, two.

VIII. Extracta, thirty-seven.

The extracts are named liquid, alcoholic, ethereal, acetic, and fresh or green extracts, according to the method of preparation.

a. Green extracts are prepared thus:—Bruise the substance used in a stone mortar, and press out the juice; heat it gradually to 130°, and separate the green colouring matter by a calico filter. Heat the strained liquor to 200°, to coagulate the albumen, and again filter. Evaporate the filtrate by a water-bath, to the consistence of a thin syrup; then add to it the green colouring matter previously separated, and, stirring the whole assiduously together, continue the evaporation at a temperature not exceeding 140° until the extract is of a suitable consistence for forming pills. Green extracts are seven in number—aconite, conium, belladonna, lettuce, hyoscyamus, colchicum, and taraxacum. The two last are slightly different from the others in their preparation.

b. Liquid extracts are eight in number: Bael, cinchonæ flavæ, opium, pareira, sarsaparilla, are made with distilled water; ergot, male fern, and mezereon, are made with ether.

IX. Glycerina, five.

X. Infusa, twenty-eight; with four exceptions the water used is boiling, but with cusparia and chiretta the water is at 120°, and with quassia and calumba, it is cold.

XI. Linimenta, sixteen.

XII. Liquores, thirty-nine.

XIII. Lotiones, two.

XIV. Mellita, four.

XV. Misturæ, eleven.

XVI. Mucilagines, three.

XVII. Pilulæ, twenty-two.

XVIII. Pulveres, fifteen.

XIX. Spiritus, sixteen.

XX. Succi, five.

XXI. Suppositoria, seven.

XXII. Syrupi, eighteen.
XXIII. Tincturæ, sixty-eight.

Forty of these are made with proof spirit; twenty-four with rectified spirit, and the remainder with ether and ammonia.

XXIV. Trochisci, ten.
XXV. Unguenta, thirty-three.
XXVI. Vapores, five.
XXVII. Vina, eleven.

PRESCRIPTIONS.

I. The heading of the prescription, the præpositio, or superscription, is written ℞. Whatever this symbol may have meant at one time, it now stands for the initial letter of *Recipe*, signifying, take of.

II. The ingredients—*materiæ designatio*, the prescription. The name of the drug is written in Latin, and is in the genitive case. The numerous constituents of any medicine are not used haphazard, but the different elements must be compatible, and must follow the rule—*curare cito, tuto et jucunde*—*i.e.*, to cure quickly, safely, and pleasantly.

The compound prescriptions may be analyzed into four parts:—

1. The basis; the active drug—*curare;* 2. the adjuvant; the auxiliary—*cito;* 3. the corrective; *corrigens*—*tuto;* 4. the vehicle; the excipient—*jucunde.*

III. The directions to the dispenser. The subscription, usually written in Latin; *misce*, mix, written *M.* *Fiat* or *fiant*, let be made, written *Ft.* *Fiat mistura*, or *fiant pilulæ viginti.*

IV. Instructions to the patients. *Signatura*, the signature. This part is usually commenced by written *Sig.* or *signa*, or *Signetur*, signifying "call it," or "let it be entitled" the mixture, draught, or what-not. After that the directions are given in English. These should be as full and complete as possible. The fashion of writing prescriptions wholly in Latin is still persevered in by a few, and at some examining boards, students are taken to task over questions of dog-latin, and are scolded and rendered nervous, and as a consequence rejected. Examiners forget that they are examiners in science, and not in classics, and that there are examiners in classics in

connexion with their corporation who have passed the pupil in Latin beforehand.

V. The name of the patient is written at the foot of the prescription.

VI. The date below the name.

VII. The prescriber's initials or name in full should be added.

PHARMACEUTICAL OPERATIONS.

Explanation of Terms.

1. *Crystallization* takes place when from any liquid salts are deposited in the form of crystals. The hot and saturated solution from which crystals are generally obtained is first strained, and then allowed to cool and crystallize. The liquid that remains, after crystallization, is called the mother-liquid. Most crystals contain a definite quantity of solidified water, called *water of crystallization*, or, when the water replaces a base, *water chemically combined*. Salts may *deliquesce*—that is, absorb water from the air and soften; or *effloresce*—*i.e.*, part with water spontaneously and crumble down. Permanent salts are those that neither absorb nor give off water.

2. *Decantation* is the separation of the supernatant fluid from a precipitate or sediment collected at the bottom of a vessel. It is best done by a guiding glass rod, the syphon, the syringe, the pipette, or by greasing the vessel rim.

3. *Maceration* is the term applied to the process of extracting the active principles of any substance by fluids without heat, thus forming cold infusions.

4. *Infusion* is a solution made with fluids at boiling-point, and allowed to cool gradually.

5. *Digestion* is when, in the preparation of any substance, a solution is kept a little below boiling-point for some length of time—*i.e.*, simmering.

6. *Decoction* is when, in the preparation of any substance, a solution is kept at the boiling-point for some time.

7. *Percolation* is filtering in such a manner that all the menstruum comes in contact with the whole of the contents of the filter, so as to get a medicated filtrate. A cylinder with perforated diaphragm is the apparatus used for the purpose.

8. *Displacement* means a change in the quantity or quality of the fluid of any saturated substance.

9. *Distillation* is the dispelling volatile compounds by heat, and then collecting them. When a gradually increasing temperature is being applied, some substances are given off at a lower temperature than others. Those given off at the lowest pass over first; this is called *Fractional Distillation.*

Destructive Distillation is a process whereby organic bodies, acted on by heat, lose their original form and yield new products.

10. *Elutriation* is a process whereby powders are separated into different degrees of fineness. The powder, which must be insoluble in water, is thrown into a tall vessel containing water. The powder gradually falls; the coarse grains first, the fine remaining longer in suspension. Now decant, and let the fine particles deposit in another vessel or vessels.

11. *Lixiviation* is the process of separation of soluble from insoluble parts of certain bodies.

12. *Granulation* is the reduction of substances to a granular condition. In the case of zinc, it is done by pouring melted zinc into water; on the other hand, tin is rendered granular by putting molten tin into a wooden box and shaking it.

13. *Trituration* is the rubbing of two dry substances to powder between two hard surfaces.

14. *Levigation* is when the substances are moistened and made into a paste before being rubbed.

15. *Pulverization.*—Before drugs are reduced to powder they ought to be *garbled*—that is, examined carefully and the adulterations and inferior qualities of the drug in question rejected. Drugs are reduced to powder in mills. In small quantity, however, a drug can be powdered by contusion, trituration, or levigation. Sometimes it is necessary to add a substance of tougher and harder consistence to aid in pulverizing. This is called *intermediate pulverization*, and the substance used is called a medium or intermedium.

PART III.

FORENSIC MEDICINE.

EXAMINATION OF THE DEAD.

Medical witnesses are constantly required to give evidence in Courts of Law as to the causes of death, and as to the effects and probable origin of wounds. Death may have resulted from violence—accidental or intentional, disease, or poisoning. In conducting post-mortem examinations, notes should be taken, *at the time*, of the appearances of every part of the body examined, and care should be taken to examine *all* the important organs and cavities systematically. In cases where wounds have been inflicted, an examination of the injured parts should be first made.

Signs of Death.—The certain signs of death are rigor mortis, cessation of the heart's action, loss of muscular irritability, and general putrefaction.

Rigor mortis sets in generally when there has been great muscular activity or exhaustion before death, and is considered by Hermann to be merely a further stage in the chemical changes which accompany muscular contraction; in death from poisoning by irritants and in other cases in which the muscles have not been active, rigor mortis sets in late and lasts long. The limits of its appearance are probably from a few minutes after death to twenty-four hours; its duration from a few minutes to a few days. Rigor mortis appears in the following order, the back, lower jaw, face, neck, chest, arms and legs, and disappears in about the same order.

Cessation of the heart's action must be judged by the stethoscope, not by the pulse, as that may be imperceptible while feeble and cardiac action is going on,

Loss of muscular irritability may not be complete for three hours after death, but when it is general it is an absolute sign of death.

Putrefaction is of course an absolute sign of death, but it is not much guide to the time at which death has taken place. Different bodies under precisely the same conditions will undergo putrefaction at very different rates.

The *cooling down* of the body has been used as an indication of the time at which death has taken place, and with some reservation it may be said that the temperature (taken in the abdomen) becomes lowered one degree per hour until the temperature of the surrounding air is reached.

Wounds.—Wounds are classified by surgeons as incised, lacerated, contused, and poisoned, and the chief legal questions which arise concerning them are :—

1. If death has resulted, were the wounds sufficient to cause death ?

2. Whether sufficient to cause death or not, was no other condition present which might have been the cause of death ?

3. Were the wounds self-inflicted, accidental, or homicidal ?

4. With what kind of instrument or with what kind of violence have the wounds been caused ?

5. In the case of living patients, what results are likely to follow the wounds ?

6. Were the wounds inflicted before or after death ?

These questions must be answered by an application of the practitioner's knowledge of physiology, anatomy, and medicine, and by a careful consideration of surrounding circumstances. When the wounds have been self-inflicted, the *instrument* which has been used will often be found tightly *clenched* in the hands. In the case of wounds from firearms there will be *blackening* of the surface, and *charring* if the weapon has been discharged at close quarters. The *situation and nature* of the wound may negative the supposition of suicide, as in stabs in the back, &c. *Inflammation round* about wounds is a sure sign that they have been inflicted before death. Clean *cuts* of large arteries *with no hæmorrhage* is an equally sure sign that the wounds have been inflicted after death, when the vessels were empty. If the wounds have been homicidal, signs of *struggle* are often present, such as cuts about the hands, bruises, and numerous wounds. The *position* in which the body is found and all surrounding circumstances must be carefully considered.

Blood Stains.—It may be necessary to examine clothes,

wrappers, furniture, &c., for evidence of the presence of blood. No test has been devised of a satisfactory nature which will decide whether a given stain of blood is that of man or of one of the common warm-blooded animals with round corpuscles. The methods of examining for blood are by the use of the microscope, spectroscope, and chemical tests.

1. Microscopic examination of recent blood clots or stains will show the presence of red and white corpuscle and fibrin.

2. Solutions containing small quantities of blood give with the spectroscope two characteristic bands appearing between D and E in the solar spectrum, that is between the yellow and green when oxydized hæmoglobin is present and one large band when deoxydized hæmoglobin is present.

3. A few drops of tincture of guaiacum and of peroxide of hydrogen, or turpentine which has been left for some time exposed to the air, strikes a sapphire blue colour if any blood is present in the solution.

4. Liquor potassæ added to blood and spread in a thin layer on a white plate gives rise to a sage green colour; the same solution is red in a test tube viewed by transmitted light.

5. Nitric acid forms a greyish coagulum with blood.

6. Dried blood, to which common salt and glacial acetic acid have been added, yields, on heating and evaporating, rhombic dark red crystals of hæmin. This is one of the best tests for the presence of blood.

7. Liquor ammoniæ added to blood produces no change of colour.

These tests exclude vegetable colouring matter, acid stains, paints, and other substances which might be mistaken for blood.

Death from Drowning.—In the case of a person found dead in water, death may have occurred from suffocation, exhaustion, shock, syncope, apoplexy, or violence. A person may have been killed, or may have been rendered insensible and then thrown into the water, or may have fallen into the water and subsequently have received injuries either before or after death.

In cases of *uncomplicated drowning* the face is pale or livid, usually calm; the tongue is swollen, and applied to the teeth; froth is found about the mouth; the lungs contain water and froth; the stomach contains water; and

the blood is said to be more watery than normal. Mud, water, weeds, &c., may be found in the air passages, and the hands often contain sand or mud or stones, which correspond with the bed of the water in which drowning took place. Retraction of the penis in men, and cutis anserina, are constantly found in cases of drowning. If the body remains in the water for some time it becomes swollen, and, as putrefaction sets in, the special signs may be difficult to make out. Where there are marks of violence it is often difficult to determine whether these have been inflicted in or out of the water, but in cases of stabbing or from gun-shot wounds there is usually little difficulty in deciding as to the cause of death.

Death by Hanging.—Hanging is usually suicidal or judicial, rarely homicidal. In ordinary cases of judicial hanging, death results from rupture of the transverse ligament of the atlas, or dislocation of some of the cervical vertebræ, and pressure on the spinal cord in the neck.

In death from hanging there is the mark of the cord on the neck. This varies in character. It may be of the nature of a bruise on the skin, which may be hard and parchment like. The face, at first pale, soon becomes livid, the tongue protrudes and the eyes are prominent. In many cases expulsion of fæces, urine, or semen and priapism are found. It has sometimes to be decided whether a person has not been killed in some other way, and then hanged to simulate suicide. The opinon of Casper is that bruises on the neck similar to those produced during life may be caused by hanging soon after death. Congestion of the brain and apoplexy would be strong evidence against post-mortem suspension. Murder by hanging is very rare, and could only take place when the homicide was comparatively extremely powerful, when several persons were associated, or when the victim had first been rendered insensible. Usually marks of violence and struggle would be found.

Suffocation may be caused by strangling, pressure on the chest, and stoppage of the nose and mouth. Post-mortem : the face is found livid and ecchymosed, the eyes are bloodshot, and the lungs and other organs are the seat of minute capillary hæmorrhage (Jardin's spots), and marks of violence are generally present. There may be marks of fingers on the throat, fracture of ribs, and appearances indicating a struggle. Occasionally suffocation is suicidal, as from strangling, and sometimes it is

accidental. Young children are often suffocated by over-laying; in these cases, probably, the greater number of deaths arises from slow carbonic acid poisoning.

Death by Starvation.—In the case of imbeciles, children, &c., homicidal starvation is sometimes effected, and accidental starvation is not uncommon. In many cases of disease, such as cancer of the stomach, or œsophagus, or stricture, death occurs from gradual starvation. A combination of disease, drink, and starvation is a very common cause of death in most large cities. The appearances of a person who has died of starvation are complete disappearance of the subcutaneous fat, emptiness and contraction of the intestinal canal, redness and dryness of the tongue, atrophy of muscles, extreme emaciation, and a peculiar fœtid odour of the whole body. The brain and heart do not suffer atrophy, being probably nourished to the last at the expense of other parts. In cases of death from starvation, especially if homicidal, care must be taken to examine every organ for signs of disease. In the Penge case, where starvation was at first considered to be the cause of death, the first medical opinion was controverted by the suggestion that death might have been caused by tubercular disease of the brain, and inanition from want of power to retain and digest food. The time necessary for death from starvation is very variable. In some cases death occurs in a few days from exhaustion, before the fat of the body has been nearly used up; in other cases, life has been prolonged for forty days or more. If water is withheld, death is always rapid, although one case is recorded in which a man survived after having been without food or drink for twenty-eight days. In a recent case, an American doctor fasted for forty days, drinking water freely.

Deaths from Burns and Scalds.—The chief medico-legal questions which arise concerning burns and scalds on a dead body are: Did these injuries produce death, and were they caused before or after death? The first question is answered by a consideration of the extent of surface injured; recovery is rare if as much as a third of the body surface is scalded or burned; and by an examination of the internal organs. With regard to the second question, it has been demonstrated by Casper and others that burns and scalds, produced during life, are accompanied by signs of inflammation and by vesications, the

fluid of the vesicles containing much albumen, while burns or scalds inflicted after death are not accompanied by inflammation, and if vesicles are formed the fluid in them contains little albumen. Vesication from putrefaction is easily recognized by the other signs of mortification.

Death from *Spontaneous Combustion* is extremely rare, if not altogether fabulous.

Death from lightning is often marked by signs of burning of clothes, of the body, and by fusion of metallic objects. Bruises and severe injuries are sometimes found; and death may occur from nervous shock, leaving no trace of violence about the body. The post-mortem appearances are neither well marked nor constant.

Infants Found Dead.—In the case of an infant found dead, the special questions which have to be answered are:

1. Was the child born alive?
2. If born alive, what was the cause of death, and how long did it survive its birth?

The first question can often be answered at once in the negative by signs of intra-uterine maceration, of mal-development, or of immaturity. In other cases the child may be apparently mature, well-developed and healthy looking, and the question can only be answered by a careful examination of internal organs. The chief test to be applied is the sinking or floating of the lungs in water. If the lungs float easily, respiration has taken place: if the lungs sink as a whole, and if when divided into small pieces, each part sinks, then the presumption is that the child has not breathed, and has therefore been stillborn. The hydrostatic test, as this method of examination is called, is open to the objection that if artificial respiration has been employed, or if putrefaction has set in, parts of the lungs may float even in cases where the child has not breathed. This objection is met by subjecting the lungs to pressure, not sufficient to destroy its texture; lung tissue artificially inflated with air or putrefactive gases will then sink, while a lung which has been naturally filled with air, will retain sufficient after pressure to make it buoyant. Other signs of live birth are, the presence of food in the stomach or intestines, the occlusion of the umbilical vein and hypogastric arteries, the closure of the foramen ovale of the heart, and other changes in the circulation; the mummification, desiccation, and cicatrization of the umbilical cord afford proofs of live birth.

If the child has been born alive, it is of importance to decide how long it has survived its birth; whether death occurred from deliberate neglect, violence, disease, or from suffocation through inability of the mother to render the child proper assistance. The state of the umbilicus is a guide to the age of the child up to the 10th or 12th day. Within twenty-four or thirty hours of birth the cord commences to wither; by the third or fourth day it is quite dry, by the sixth or seventh day it has separated from the body, and by the tenth or twelfth day cicatrization is complete.

In deciding on the cause of death, we must look for marks of violence, and of disease, and be guided also by the circumstances under which the body has been found, in the same way as for adults.

Adults Found Dead.—Excluding the cases considered elsewhere, wherein death is due to violence or poisoning, sudden death may in the great majority of cases be traced to disease of the heart or great vessels, of the lungs, or of the brain. The conditions of the heart and great vessels which most commonly cause sudden death are, fatty degeneration, valvular incompetence, especially aortic, cardiac neuralgia (angina pectoris), and the rupture of aneurisms. In angina pectoris the usual pathological condition is ossification of the coronary arteries. In death due to paralysis of the right side of the heart, or from asphyxia, the right ventricle is found full of fluid or clotted blood, while the left is empty; when the left side is paralyzed the conditions are reversed.

Brain lesions affecting the fourth ventricle or extensive hæmorrhages into the lateral ventricles may cause death more or less sudden. Pulmonary apoplexy or copious hæmoptysis may cause sudden death from suffocation. In all investigations into the causes of death we must repeat what we have said elsewhere, the examination of the body must be thorough and complete.

DEATH FROM POISONING.

The duties of a medical man in cases of poisoning are, to recognize and treat the condition, and to preserve evidence of the presence of poison for use in a court of law. The symptoms of acute and chronic poisoning often resemble those of disease, but the following considerations will often lead to the detection of poison :—

1. In acute poisoning the symptoms come on suddenly, often in a person or persons in good health.

2. The symptoms come on after taking food or drink.

3. If after a meal, a person or persons who have partaken of a particular dish become ill, while others who have not touched it are unaffected, there is evidence that the dish may be poisonous.

4. The symptoms of different poisons are various, but pain, vomiting, purging, convulsions, delirium, stupor, arising without apparent cause, are suspicious.

5. Animals, partaking of certain suspected food or vomited matters, have sometimes indicated the presence of poison.

6. In the case of corrosives, the lips, mouth, and throat show signs of the action of the poison.

In all cases of suspected poisoning, vomited matters, stools, urine, remains of food, drink, and medicine, taken by the patient, should be secured if possible. Vomit, &c., should be preserved in clean vessels and carefully labelled. In conducting post-mortem examinatious notes should be taken of every appearance, external and internal, which might indicate diseased conditions or the presence of poison. The intestines should be examined externally in every part, and any appearance of ulceration, irritation, &c., noted. Clean jars, with tightly-fitting stoppers, should be got ready for the reception of different organs. The stomach, œsophagus, portions of the intestine, bladder and any other viscus it is desirable to examine, should be removed and placed in separate jars, care being taken to apply ligatures so as to prevent the escape of any contents of the alimentary canal. Each jar should then be sealed and numbered—an exact note of the contents corresponding to the numbers on the jars being made. Where analysis is required these jars should be forwarded to an analyst, and a letter of advice should be posted to him, at the same time giving all particulars as to their contents. Every care should be taken of the security of the jars, and, if possible, some record should be kept of every step taken until they are safe in the hands of the analyst. Chronic poisoning is common in certain trades and occupations, and poison may be intentionally administered in small doses for criminal purposes. Failing health, gastric irritation, and frequent exacerbation of symptoms may give rise to suspicion if there is no physical cause to account for these phenomena. An examination of the urine in some cases may determine the presence of poison.

CLASSIFICATION OF POISONS.

Poisons may be classified according to their chemical nature into Inorganic and Organic, or, according to the symptoms they produce, into—

Corrosives,	Heart Poisons,
Irritants,	Nerve Poisons.
Asphyxiants,	

It will be convenient to consider, first, the—

INORGANIC POISONS.

CORROSIVES.

The mineral acids, hydrochloric acid or spirit of salt, nitric acid or aqua fortis, and sulphuric acid or oil of vitriol, poison by their destructive action upon the tissues with which they come in contact. The symptoms produced by them, when swallowed, are, a sour taste, intense burning pain in the mouth, pharynx, œsophagus and stomach, retching and vomiting of blood-stained mucus, difficulty in swallowing and breathing, and collapse. Marks of corrosion are visible about the lips and mouth. Death may occur at once from shock, or more gradually from exhaustion, or after weeks or months from mal-nutrition, or recovery may take place.

Treatment.—Calcined magnesia, soap suds, whiting and chalk or other alkaline remedies should be given at once. Demulcents, such as milk and oil, should also be freely given to dilute the acid and protect the surface of the stomach.

Special Symptoms and Fatal Doses:—

Sulphuric Acid chars organic matter, stains black cloth red, and green cloth black; from its affinity for moisture the stain keeps damp.

Fatal Dose.—In an adult one drachm has proved fatal.

Nitric Acid stains the skin, and organic matter generally, yellow, and black cloth red.

Fatal Dose.—Two drachms.

Hydrochloric Acid whitens the mucous membrane and skin, and stains black cloth green, or first red and then green.

Fatal Dose.—One drachm has proved fatal.

Tests.—See Practical Chemistry Table. Acid group.

The strong alkalis, potash, soda, and ammonia act, like the acids, as corrosive poisons. They are hardly so

energetic, and no cases of perforation are known to have been produced by them. The symptoms are those of corrosion, pain of a burning character, vomiting and collapse. The parts touched by the strong alkalis are corroded and whitened. The treatment consists in giving dilute vinegar or other acid drinks, and demulcents to dilute the poison and protect the mucous membrane.

Fatal Doses.—Four drachms of caustic potash has proved a fatal dose; one drachm of strong liquor ammoniæ has proved fatal.

IRRITANTS.

Among inorganic substances which produce irritant effects are the salts of most of the metals when taken in large doses—thus, common salt, iodide of potassium, nitrate of potassium and sodium, lime salts, baryta salts, and others may prove poisonous. The general treatment required is to empty the stomach by emetics or the use of the stomach-pump. The best emetics to use are hot water with salt or mustard, or ipecacuanha. Subcutaneous injection of apomorphia, if at hand, acts very effectually. A good improvised stomach-pump may be made out of a piece of india-rubber tubing, about forty inches long, and not too thick to pass down the œsophagus. It should be oiled, and then passed along the posterior wall of the pharynx. Warm water may be poured into the raised external end, and whilst the end is still in the stomach, by subsequently depressing the outside part, the fluid from the stomach will flow out. Demulcents, such as oils, mucilage, white of eggs, &c., should also be given. For the various tests for the metals consult the Practical Chemistry Tables.

PHOSPHORUS acts as an acute irritant, the symptoms being similar in kind but less in degree than those produced by corrosives. Soon after being taken there is burning pain in the epigastrium, throat, and mouth. Nausea and sickness, colic and diarrhœa usually follow. In a day or two jaundice sets in, and low typhoid symptoms are apt to come on; delirium, more or less acute, stupor, and coma, are present before death. Sometimes nervous symptoms predominate, and sometimes there are copious hæmorrhages into the mucous surfaces and into the skin as in purpura. Death may come on rapidly or after some weeks of lingering illness, or recovery may take place. Post-mortem : Besides irritation

of the alimentary canal, there is found fatty degeneration of all the important organs of the body. It is partly owing to the secreting glands being so affected, that many of the symptoms which resemble biliary and uræmic toxæmia are due.

Fatal Dose.—A tenth of a grain may produce serious symptoms, and death may follow doses of less than a grain.

Treatment.—Give oil of turpentine, suspended in mucilage, in 40 minim doses (four or five doses) every fifteen minutes, and emetics of sulphate of copper. Magnesia should be given afterwards, and demulcents. All other oils must be avoided as they dissolve phosphorus.

Tests—1. Phosphorus is luminous in the dark. 2. When sulphuric acid is added to organic matter containing phosphorus, and the whole distilled in the dark, a luminous vapour is produced. 3. Slips of paper, moistened with nitrate of silver solution, become blackened when suspended over a mixture containing phosphorus. To show that the blackening is not due to sulphuretted hydrogen, slips of paper dipped in acetate of lead should be used at the same time. 4. A modification of Marsh's method for the detection of arsenic may be used. The suspected substance is mixed with nascent hydrogen, when, if phosphorus is present, phosphoretted hydrogen is formed, which burns with a green flame. Platinum nozzles must be used for the tube through which the gas escapes.

Iodine produces symptoms of acute irritant poisoning. Small doses, given frequently, may produce chronic irritation, wasting of glands, and skin eruptions (hydroa, &c.).

Treatment.—Emetics and starchy matters as antidotes.

Tests.—Iodine sublimes, on heating, in a purple vapour; on cooling it falls in brown scales, which stain the fingers brown; the stains are easily removed by caustic potash.

Arsenic and Antimony.—The symptoms produced by these poisons usually appear soon after they have been taken. Pain, nausea, vomiting and purging; tenderness of the abdomen, headache, swelling of the eyes; a full, quick pulse, palpitation, intense restlessness, delirium, and coma have been observed among the symptoms. Usually the mental faculties are not affected until towards the end. It is hardly possible to tell from the symptoms whether arsenic or antimony has been taken; thus, in the Bravo poisoning case it was thought the

patient was suffering from arsenical poisoning, until the chemical analysis showed that tartar emetic had been used. Chronic arsenical poisoning has often been mistaken for typhoid fever.

Treatment.—Arsenic.—Freshly precipitated peroxide of iron, made by adding ammonia to perchloride of iron, is the most efficient antidote. Magnesia, precipitated from solution of the sulphate by caustic potash, is also useful. Emetics and purgatives should be given, if necessary, or the stomach may be washed out with the stomach-pump. Afterwards sedatives should be given, and the state of collapse should be treated with stimulants.

Antimony.—Tincture of cinchona, and liquids containing tannin, such as strong tea and coffee, are the best antidotes. Vomiting should be encouraged by warm drinks; demulcents, sedatives, and stimulants should be given as required.

Tests.—See Tables of Practical Chemistry.

Fatal Doses.—Two-grain doses of arsenic and antimony have proved fatal; but much larger doses have often been taken, and recovery has followed.

The common preparations of arsenic are the white oxide, the sulphide, and the salts of soda, iron, and copper; and those of antimony, tartar emetic, chloride of antimony, and the oxide.

Mercury.—The mercuric salts are extremely poisonous, while the mercurous salts, except in cases of Bright's disease, or of peculiar individual idiosyncrasy, are usually harmless. The symptoms produced by mercuric salts are those of acute gastric and intestinal irritation, with vomiting and purging; a strong metallic taste is felt in the mouth; the pulse is quick and nervous.

Symptoms.—Coma, delirium, cramps, &c., may be very marked. If the patient survives, salivation comes on—it may be in a few hours, rarely under twenty-four.

Treatment.—After, or before, the administration of emetics, and the use of the stomach-pump, the white of egg dissolved in water should be given; this forms an insoluble albuminate of mercury.

The commonest poisonous salt of mercury is the perchloride, or corrosive sublimate. The oxides, the bicyanide, and other salts, are sometimes taken. The bicyanide of mercury poisons by its mercurial action, not as a cyanide.

Lead.—Lead most commonly exerts its poisonous influence on those who work in the metal, or through drink-

ing water stored in lead cisterns, or passing through lead pipes. The symptoms of chronic poisoning are gradual loss of strength, attacks of colic, and obstinate constipation, neuralgia, paralysis of the extensor muscles of the fore-arm, albuminuria, and a tendency to gout; a blue line forms at the junction of the teeth and gums. Acute poisoning is marked by irritant symptoms.

Treatment.—For acute poisoning emetics should be given. Sulphate of magnesia is the most useful drug, as it acts as a purgative, and forms an insoluble sulphate with any soluble lead salts present in the alimentary canal. For chronic poisoning withdraw the patient from exposure to the poison. Iodide of potassium and sulphate of magnesia should be given, and paralyzed muscles should be galvanized.

Tests.—See Table of Practical Chemistry.

Copper.—The salts of copper resemble other corrosive poisons in their general actions. The symptoms peculiar to them, are—that the vomit is coloured green or blue, and that jaundice, with a full gall-bladder, is a usual accompaniment.

ORGANIC POISONS.

CORROSIVES.

Carbolic Acid.—Pure carbolic acid, like a mineral acid, has a strong corrosive action on the skin and mucous membrane. When swallowed the ordinary symptoms of a corrosive poison are produced, and the œsophagus, stomach and intestine, are softened, and become of a silver grey colour; the mouth and face are usually stained by its action. Carbolic acid also produces delirium and coma, when absorbed, and is sometimes classed among the deliriants.

The treatment consists in the use of the stomach-pump, and the administration of olive or linseed oil. Saccharated lime is said to be an efficient antidote.

Tests.—1. Its peculiar odour.

2. Perchloride of iron gives with it a dark blue colour.

3. Bromine water added in excess gives even with minute granules a flocculent yellow precipitate.

4. A solution of hypochlorite of sodium and ammonia gives a light blue colour.

5. It is volatile, and can be distilled from organic solutions.

6. A piece of fresh deal dipped in the strong acid, and then in hydrochloric acid, becomes greenish blue in colour.

Fatal Dose.—Probably about a drachm.

Oxalic Acid.—The symptoms produced by oxalic acid are, a strong acid taste, burning in the throat and stomach, vomiting and collapse. The mucous membrane of the mouth, œsophagus and stomach, is shrivelled, of a worm-eaten appearance and softened.

Treatment.—Chalk, lime water, or magnesia (*i.e.*, alkaline earths), should be given. The alkalis unite with oxalic acid to form soluble poisonous salts, so must not be given.

Fatal Dose.—Half an ounce.

Tests.—See Practical Chemistry Table.

IRRITANTS.

Most poisons have a direct irritant action in the intestinal canal, as well as certain special effects on other organs, such as the brain, heart, and spinal cord. The number of organic poisons is very great, so that only a few of the most common can be mentioned here.

Cantharides.—The various preparations of the Spanish fly, or cantharis vesicatoria, when taken internally in large doses, act as strong irritants upon the alimentary canal, and upon absorption, on the genito-urinary system. The main symptoms are burning pain, vomiting, tenesmus, bloody stools, priapism, and blood in the urine.

The *treatment* consists in giving emetics, diluents, and demulcents.

Tests.—The active principle, cantharidine, can be easily separated by sublimation, and very small quantities of it will produce blisters on the skin or mucous membrane.

Among the other irritants yielded by the animal and vegetable kingdom, are putrid and diseased meats and fish, various fungi, and the vegetable purgatives, such as colchicum, elaterium, croton oil, &c. The general symptoms produced by these are, vomiting, purging, and irritant effects, which may lead to collapse.

The *treatment* consists in promoting the discharge of the noxious matters, giving stimulants and demulcents, and opium when necessary to allay pain and purging.

NARCOTICS.

Opium, Morphia.—Given in large doses, opium or morphia soon induces sleep, from which at first the patient can be roused, but which in its later stages passes into profound coma. The skin is bathed with perspiration, the pulse is quick, and breathing is hurried; but in the later stages both the pulse and respiration become slower. Death usually occurs within six or eight hours, or recovery takes place. The pupils are in the great

majority of cases much contracted; very exceptionally dilatation has been noticed, or dilatation of one pupil and contraction of the other. Apoplexy from hæmorrhage into the pons Varolii and uræmia present some of the symptoms of opium poisoning.

Treatment.—Emetics should be given, and the stomach should be washed out with the stomach-pump. Every endeavour should be made to rouse the patient, and to keep him awake when he is roused. Cold affusion, flagellation, galvanism, and the administration of strong coffee, are the most useful methods. Belladonna has been used as a physiological antidote, but opinions are conflicting as to its effect, some authorities saying it is useless or harmful, while cases have been published which seem to prove its efficiency as an antidote.

Fatal Dose.—This is very uncertain. A few drops of laudanum have proved fatal in young children, and immense doses of opium or morphia have been taken by persons habituated to its use with no ill effects. In persons suffering from Bright's disease, and in acute bronchitis, it is often fatal in comparatively small doses. In the case of an adult not protected by habitual use of the drug, or specially sensitive to its action, four grains of opium and a grain of morphia may be stated as the minimum fatal doses.

Tests.—The tests for opium depend on the detection of morphia and meconic acid. Sometimes the presence of the drug may be detected by the smell.

Chemical Tests.—1. Acidulate with acetic acid, add acetate of lead, and filter. Insoluble meconate of lead remains on the filter; acetate of morphia and some acetate of lead remain in solution.

2. Test for meconic acid. Add sulphuretted hydrogen to the meconate of lead, agitate, and filter. Meconic acid passes through, and insoluble sulphide of lead remains on the filter. Meconic acid strikes a blood-red colour with perchloride of iron, which is discharged on the addition of a solution of perchloride of mercury.

3. Tests for morphia. Remove excess of lead by the addition of sulphuretted hydrogen. Filter, and evaporate the filtrate to a syrupy consistence, saturate with carbonate of potash, and add ether to extract the morphia.

(*a.*) Add perchloride of iron to morphia; it gives a bluish black colour.

(*b.*) Add nitric acid; it becomes orange red.

(*c.*) Add hydriodic acid and starch; the morphia sets iodine free, which unites with the starch, forming blue iodide of starch.

Sometimes the most careful application of tests will fail to discover opium or its constituents, even when it has been taken in considerable quantity.

Chloral Hydrate.—Taken in large doses, chloral produces symptoms much resembling those of opium poisoning. The pupils are not so intensely contracted, and generally become dilated before death.

Treatment.—Emetics should be given, and the patient should be roused as in opium poisoning. The subcutaneous injection of strychnine has been recommended.

Tests.—If chloral is passed through a red-hot tube, chloroform vapour is given off. If solid caustic potash is added to the crystals, or to a solution of chloral, chloroform is given off.

Fatal Dose.—Death has resulted from doses of about eighty grains; but much larger doses have been taken and given medicinally with no ill effect. The continued use of chloral is dangerous, as death may result from its cumulative action, or from the lowering of the resisting powers of the body.

CONVULSANTS.

Strychnia.—The symptoms produced by strychnia show themselves within half-an-hour of taking the poison. There is first a feeling of suffocation, then general convulsion of all the muscles of the body, those of the face, however, being often little affected. From the excessive action of the extensors, the patient's body is often arched, so that his head and heels only touch the bed (opisthotonos). The spasms come on in paroxysms, between which there may be complete remission of symptoms. The face is drawn into a grin (risus sardonicus), and livid; the pupils are staring; there may be foaming at the mouth, and sweating during the fits. The least external irritation, cold air, the touch of bed clothes, &c., brings on a convulsive attack. Death takes place within six hours, or the patient recovers. Strychnia poisoning resembles tetanus, but differs from it in the following points:—

Tetanus follows a wound. Comes on gradually; the jaw muscles are first affected; there is no complete remission between the paroxysms, and death does not

occur, as a rule, until after a few days. Strychnia convulsions follow swallowing an intensely bitter substance; come on quickly; the jaw-muscles are affected late, or not at all; there is complete remission between the paroxysms, and death occurs within a few hours, or not at all.

Treatment.—Emetics should be given, and the stomach-pump used as promptly as possible. Chloral hydrate should be given internally, and large doses of bromide of potassium have proved useful. Chloroform inhalations are especially useful during the paroxysms.

Fatal Dose.—A quarter of a grain has destroyed life.

Tests.—1. Its intensely bitter taste.

2. The physiological test.—This is applied on frogs which are exceedingly sensitive to strychnia. Very small doses injected subcutaneously produce tetanic spasms.

3. Chemical tests.—To a crystal of strychnia add sulphuric acid, and then place a crystal of bichromate of potash on the mixture; a play of colours is produced, at first blue, then purple, then crimson, and finally red. A similar play of colour can be produced by substituting for bichromate of potash, the permanganate of potash, peroxide of lead, peroxide of manganese, or ferrocyanide of potassium.

If the strychnia is in solution, or in organic mixture, it must be dissolved out by ether, benzole, or chloroform. The method of Stas (p. 320) is the best for the separation of the various alkaloids from organic matter. Strychnia is the most stable of the alkaloids. It has been found in human remains after many years.

Nux vomica and brucia produce the same symptoms as strychnia, but they are less energetic in their action.

DELIRIANTS.

Belladonna and Atropine.—Atropa belladonna or deadly nightshade, is indigenous in this country; it yields a small purple berry, which is sometimes eaten by children. Various preparations of the root and leaves, and of the alkaloid atropia, are in the British Pharmacopœia, and are sometimes the cause of poisoning. The symptoms generally come on about two hours after taking the drug; there are thirst, dryness of the throat, giddiness, mental excitement, delusions, and intestinal irritation. The pupils are widely dilated, the eyes become prominent,

and vision is indistinct or lost. Sometimes an eruption like that of scarlet fever appears on the skin.

Treatment.—After the use of emetics and the stomach-pump, animal charcoal or liquor potassæ should be given. The subcutaneous injection of morphia may be tried.

Tests.—The chief test is the physiological one. Small quantities of solution containing belladonna applied to the eye will produce dilatation of the pupil.

The other poisons belonging to this group, are the different parts of hyoscyamus niger or henbane, of datura stramonium or thornapple, of solanum dulcamara, bittersweet, woody nightshade, of camphor, of œenanthe crocata, of hemlock, water dropwort, and of cocculus indicus. The treatment is that for ordinary irritant poisoning, and for poisonous alkaloids—viz., by emetics, stomach-pump, charcoal, and potash.

HEART POISONS.

Hydrocyanic Acid (Prussic Acid).—When taken in a large dose prussic acid usually causes death from syncope in a few minutes. The patient may be able to perform certain acts, such as getting into bed, locking a door, &c. If death does not occur at once, the symptoms are those of shock or collapse; the patient becomes insensible, the jaw is fixed, and urine or fæces may be discharged involuntarily. In many cases a peculiar low cry is uttered just before death.

Treatment.—On account of the rapid action of this poison, and the fixed state of the jaw, antidotes are usually of little use; chlorine water and the oxides of iron are the ones usually recommended. Cold affusions to the face and chest, artificial respiration, and stimulation of the heart with galvanism should be tried.

Fatal Dose.—Forty-five minims of the dilute acid of the Pharmacopœia.

Tests.—The poison is extremely volatile, and can seldom be detected in the body after the lapse of a little time. The tests for this acid are given in the Tables of Practical Chemistry.

Cyanide of Potassium, preparations of bitter almonds, and the cherry laurel, poison in the same way as prussic acid. The treatment and tests are the same as for that poison. Five grains or less of cyanide of potassium have proved fatal.

Aconite.—Aconitia.—Monkshood or Aconitum napellus

is a common plant in this country; preparations of its root and leaves are used in pharmacy, and a very deadly alkaloid, aconitia, is contained in all parts of the plant. The symptoms produced by aconite are tingling of the lips and tongue, a burning sensation in the stomach, pain, vomiting, intense depression, and finally failure of the heart's action. In a recent case, in which Lamson, a medical practitioner, poisoned a lad with aconitia, the symptoms came on about twenty minutes after the poison was taken, and death took place in four hours. The main symptoms were heartburn, pain in the stomach, vomiting, "drawing up of the skin," constriction of the throat, and great restlessness. The mind was clear until near the end, when slight delirium came on, followed by death from syncope.

Treatment.—The stomach and alimentary canal should be cleaned out as promptly as possible. Stimulants, such as brandy, ammonia, and ether should be given, and heat and friction applied to the body. Digitalis has been used successfully as a physiological antidote.

Fatal Dose.—A drachm of tincture of aconite, and about a tenth of a grain of aconitia may be sufficient to cause death.

Tests.—There are no exact tests for aconite or aconitia. The chief means for its recognition are—

1. The peculiar numbing effect of aconite on the lips and tongue.
2. Its action on the lower animals.
3. The fact that an alkaloid can be detected by Stas's process (p. 320).

DIGITALIS.—DIGITALIA.—Digitalis purpurea, or the common foxglove, is an indigenous plant of very common distribution. The leaves and other parts, containing the alkaloid digitalia, produce symptoms of irritant poisoning, but act especially on the heart; the cardiac movements are slowed, and if a large dose of the poison is taken, rendered weak, irregular, or stopped altogether. Nausea and faintness, cold sweats, salivation, dilatation of the pupil, and stupor are the common symptoms. Sometimes death is quite sudden.

Treatment.—After emetics and the stomach-pump have been used, brandy and other stimulants should be given. The recumbent position should be maintained, and friction and other external stimulants, as in aconite poisoning, should be applied.

The Fatal Dose is doubtful. In delirium tremens and

other diseases, very large doses have been given, with no evil results.

Tests.—Digitalis causes slowness and irregularity of the frog's heart, and in sufficient doses stops it in systole. The other tests depend on the detection of the alkaloid by Stas's and other methods (p. 320).

White hellebore and its alkaloid veratrium produce symptoms similar to aconitia.

DEPRESSANTS.

Conium Maculatum.—The spotted hemlock or conium maculatum is an indigenous plant. The leaves have often been mistaken for those of parsley. The symptoms produced by conium are gradual paralysis, and death is caused by paralysis of the respiratory muscles; dryness of the throat, difficulty in swallowing, nausea, drowsiness, and great muscular weakness are sure symptoms.

Treatment.—Emetics should be given, and stimulants freely used.

Tests.—All parts of the plant have a peculiar mousy odour, which is brought out strongly on the addition of liquor potassae. The chemical tests depend on the presence of the alkaloid conia.

Calabar bean, tobacco, lobelia inflata and curara belong to this group. In poisoning by Calabar bean, contraction of the pupil is a prominent symptom, and spinal paralysis is produced by it. Curara seems to act upon the endings of the motor nerves in muscles, and thus produces motor paralysis.

Poisonous Gases. — This class includes chlorine gas, ammonia, sulphurous acid, nitrous acid, hydrochloric acid, &c. These act by inflaming the mucous membranes, and may produce fatal spasm of the glottis. Other gases, such as carbonic oxide, carbonic acid, act by depriving the blood of its due supply of oxygen.

Carbonic oxide (CO) combines with the hæmoglobin of the blood, setting free the oxygen. Very small quantities of this gas will thus produce death by what has been called "paralysis of the blood corpuscle." Carbonic acid (CO_2) is only poisonous when present in large quantities. It acts by taking the place of oxygen; death is usually quiet and gradual, or if the quantity of carbonic acid present is very great or added suddenly, there may be symptoms of rapid suffocation.

Sulphuretted hydrogen (H_2S) seems to act by uniting with the oxygen of the blood.

Coal gas produces headache, drowsiness, or delirium, and poisons by asphyxia. The treatment of the various forms of poisoning by gases consists in taking the patient at once into the fresh air, applying stimulants, to the surface, and, if necessary, performing artificial respiration.

EXAMINATION OF THE LIVING.

Medical men may be called upon to give evidence or to furnish certificates as skilled witnesses for many purposes.

The following are some of the chief cases :—

1. In railway and other accidents to estimate the amount of damage done to bread-winners and others.
2. In cases of ordinary assault.
3. In cases of rape and similar crimes.
4. Examinations have sometimes to be made to decide if a woman has recently borne a child, if a woman is pregnant, &c.
5. Cases of alleged impotence may have to be reported on.
6. Reports have frequently to be made to life assurance and friendly societies.
7. Persons who are supposed to be of unsound mind may have to be examined and certified.

In case of railway and other accidents the general rules to be observed are :—

1. To examine the patient carefully, and, as much as possible, to compare his previous with his present state.
2. To give what evidence has to be given in the clearest and least technical language.
3. To be careful in giving evidence to avoid stating matters of opinion as matters of fact.
4. To avoid any suspicion of partisanship. In all accidents involving nervous shock or injuries to nervous centres, the greatest care must be taken in giving a prognosis.

In giving evidence as to the effects of violence, the medical witness has usually only to describe the nature of any wounds or bruises he may have examined, and to state how such injuries may have been produced. The ordinary rule of evidence will apply equally in such cases as in cases of accident. Malingering and exaggeration of symptoms in all such cases are very common, requiring,

usually, considerable caution in separating subjective from objective phenomena.

Rape and Indecent Assaults.

Rape is defined as "the carnal knowledge of a woman against her will," and to substantiate the crime, proof of penetration of the vulva, with or without emission, is sufficient. Carnal knowledge of a girl under ten years of age, with or without consent, is a crime equal in the eyes of the law with rape. The carnal knowledge of a girl between the ages of ten and twelve years is a crime of less gravity than rape, but punishable by three years' imprisonment,

The medical evidence of rape is based on the appearance of marks of violence about the genitals and elsewhere in females, and the presence of seminal spots on the clothing of the female or of the accused. Other circumstances, such as the age and relative strength of the persons, the administration of narcotics, inebriants, or excitants, and the place and time of the alleged assault have to be considered. In children and in virgins there will usually be found considerable injury to the genitals; marks of bruising, bleeding, puriform discharge, and sometimes sloughing of the pudenda, may occur. If the accused is labouring under any venereal complaint the transference of this to the female may be evidence of intercourse, but leucorrhœal discharges in females are not, as a rule, to be easily discriminated from gonorrhœa, and may occur from a variety of causes; their presence is, therefore, no sure sign of infection. In all cases the examination should be made as soon as possible after the alleged crime; leading questions should be avoided, and no time for preparation or concealment should be allowed. In examining linen for seminal spots the parts stained should be cut out and soaked in a little water. Afterward the linen should be squeezed out on a glass slide and an examination made with a microscope, for seminal stains on linen turn yellow when gently heated.

Pregnancy may follow rape.

Pregnancy.

In the case of condemned criminals, of a wife supposed to be pregnant with a child which may be heir to an estate, and in some other cases, an examination may have to be made to decide upon the question of pregnancy.

The usual limits of child-bearing in this country are between the ages of thirteen years and fifty years, but cases of precocious and late pregnancy are not uncommon. The signs of pregnancy (*see* Midwifery) may be divided into the certain and uncertain. Of the former class there are two which can be relied on :—

1st. The sound of the fœtal heart, heard with the stethoscope, only after the fourth month.

2nd. The presence of the foetus in utero, determined by repercussion or ballottement. This sign is not present before the fourth month, and cannot usually be elicited much after the sixth.

Among the uncertain signs are suppression of the menses, enlargement of the abdomen, turgescence of the nipples and breasts, pigmentation round the nipples and elsewhere, or uterine murmur, &c., all of which signs may be present with uterine tumours or from other causes.

The signs of *recent delivery* include many of the uncertain signs of pregnancy. The uterus can be felt somewhat enlarged, there may be signs of laceration about the vagina, white streaks are present over the abdominal walls, which are relaxed and flacid, and there will be a discharge from the vagina, at first bloody, afterwards leucorrhœal in character. The signs of recent delivery in the dead include enlargement of the uterus, and the presence of clots and laceration on its inner surface, but both in the living and in the dead, if the examination does not take place within a few days of the supposed delivery, the appearances are very uncertain and unreliable.

Impotence.

Impotence in the male or female, if it has existed at the time of marriage, is sufficient grounds for divorce. In cases of alleged rape and of contested legitimacy impotence in the male may be alleged. In all cases where the genital organs are duly developed and healthy, the legal presumption is against impotence. Non-descent of the testicles, or disease or absence of one testicle, may be accompanied with full procreative power. The removal of the testicles in early life, their total destruction by disease, or the absence of the penis, may be held as proof of impotence. In the female, congenital malformations or disease may render intercourse impossible, and thus cause impotence. In some cases, where

the husband cannot be examined, the wife may have to be examined for signs of virginity.

Life Insurance.—Friendly Societies.—In all cases of examination for life insurance and friendly societies, a strict examination should be made of all the important organs of the body. Usually such associations provide regular forms of questions to be answered, thus lessening the responsibility of the medical adviser.

Insanity.—Medico-legal questions as to insanity may arise concerning wills, contracts, the disposal of property, the responsibility of criminals; and all lunatics, before being placed in asylums, must be certified by medical men to be insane. In giving certificates of insanity for the purpose of having patients removed to an asylum, the medical witness is usually provided with printed forms giving full instructions and rules to be observed in filling up the certificate. The following are the chief points to be observed:—

1. One medical certificate is sufficient in the case of pauper lunatics.

2. The certificates of two medical men are required in all cases where the patient is not a pauper.

3. The certificates hold good for seven days only. If the patient has not been removed to an asylum within that time, fresh certificates and fresh visits are required.

4. The two medical men must not be in partnership, nor may one be the assistant to the other.

5. The visit to the patient must be made separately, and the patient must be seen by each medical man apart from the other.

6. The certificate should be signed and made out at the time of the visit.

7. The medical men giving the certificate must have no interest, direct or indirect, in the asylum to which the patient has to be sent.

8. The certificate must give the exact name, age, occupation, and usual address of the patient; the place where the patient was seen, the date of the visit, the name, address, and status of the practitioner.

9. The certificate must set forth the reasons inducing the medical man to consider the patient insane. These must include facts observed by himself. If statements have been made by others influencing his opinion, he may mention them, giving the names of his informants. Informal certificates may be altered within the prescribed ime.

In giving evidence in courts of law no exact definition of insanity can be given, or should be attempted. The best classification of insanity is that given by Drs. Guy and Ferrier in their "Manual of Forensic Medicine." Recognizing that the mind may be undeveloped, degenerated, or disordered, they classify unsoundness of mind under three headings—viz., amentia, dementia, and mania.

I. Amentia, includes all cases of *idiocy, imbecility,* and the peculiar condition of physical and mental disease known as *cretinism.* No hard-and-fast line can be drawn between these conditions. In the lowest forms of amentia the patient is untractable, absolutely devoid of intelligence, and leads a purely animal existence. In the higher class of idiots and imbeciles, there is often considerable capacity for acquiring knowledge, and for performing the ordinary business of life if properly guided.

II. Dementia, includes cases of *acute and chronic* degeneration of the mental faculties from disease or shock, *senile degeneration,* and the degeneration consequent on *general paralysis or paresis.* These forms are marked by incoherence, languor, or stupor. In general paralysis of the insane there is usually much exaltation of ideas; the patient imagines that he possesses millions of money, and that he has extraordinary powers of various kinds; restlessness, petty thefts, and extravagance of a ruinous kind are frequent symptoms; tremor of the lips, and hesitation of speech are marked symptoms, and, as the disease advances, general paralysis sets in; death usually occurs within two years, and is caused by exhaustion or by paralysis of the pneumogastric and glosso-pharyngeal nerves. General paralysis is more common among men than women, and among the richer than the poorer classes; it generally commences between the ages of thirty and sixty years. The signs of paralysis may be evident before the mind is affected, a point sometimes of importance in cases of disputed wills. The causes may be anxiety, intemperance, or injuries to the head, &c.

III. Mania includes all those cases of insanity in which emotional excitement plays the chief part. It may be *general,* or involving complete mental incoherence and moral disturbance, *intellectual* or *moral.* Intellectual mania may be general or partial, and it generally has an incubative period, in which the patient suffers from depression, restlessness, excitement, headache, and other forms of disturbance. In moral mania the patient may be possessed of keen and correct intellectual faculties, but

may be completely devoid of the moral sense—a kind of moral idiot, without honour, honesty, or any sense of duty towards others. In many cases the moral mania is only partial, and may take special forms, such as kleptomania, dipsomania, pyromania, erotomania, &c.

FROM GUY AND FERRIER.

Stas's Process for Extracting Alkaloids from Organic Matter.

1. The organic matter, treated with twice its weight of absolute alcohol, and from ten to thirty grains of tartaric or oxalic acid, is heated in a flask to about 160° Fahr. till brought to a state to pass the filter. This alcoholic acid mixture, being allowed to cool, is filtered, and the filtrate evaporated to dryness. 2. This dry residue, dissolved in a little distilled water, is then treated with bicarbonate of soda, and the alkaloid set free. 3. The resulting liquid, holding the alkaloid dissolved or suspended, is poured into a long tube with four or five times its bulk of ether, briskly shaken, and then left at rest. The ether floats on the surface holding the alkaloid dissolved. 4. A part of this ethereal solution is now poured into a watch-glass and allowed to evaporate. It may have contained a *volatile* or a *fixed* alkaloid. If volatile, oily streaks will appear on the glass; if fixed, a deposit with some traces of a crystalline formation. From this point the procedure varies with the indications thus obtained.

For the *volatile liquid alkaloids* the procedure is as follows:—From fifteen to thirty grains of a strong solution of caustic potash or soda are added to the liquid in the tube, which is again briskly shaken, and again allowed to stand. The ethereal solution is next drawn off by a pipette, and shaken with a little water acidified with sulphuric acid. The ether is again drawn off, leaving the alkaloid as sulphate in the water, to be treated with excess of caustic potash or soda. The alkaloid is thus set free, to be again shaken up with ether and dissolved by it. On slowly evaporating the ethereal solution, the alkaloid may be obtained in a state of sufficient purity.

For the *fixed alkaloids* the process consists in treating the contents of the tube with the same quantity of a strong solution of caustic potash or soda, shaking briskly, causing it to stand till the ethereal solution rises to the surface, drawing this off with the pipette, and allowing it to evaporate. The residue, which is either solid or a thick milky liquid, if treated with a few drops of alcohol, and allowed to evaporate, may yield crystals of the alkaloid. But if not, a few drops of water slightly acidulated with sulphuric acid are added, and the watch-glass carefully rotated. A soluble sulphate of the alkaloid is thus formed, which being carefully drawn off, or filtered, may be neutralized by a strong solution of carbonate of soda, the alkaloid set free, dissolved by absolute alcohol, and evaporated. Crystals will now form.

PART IV.

MEDICINE.

FEVERS.

Fever is a general term applied to any condition of the body in which the temperature is raised above 98° or 99° Fahrenheit. The febrile condition may be due to some local disorder occurring in any of the tissues or organs of the body from injury or disease, and the fever is then called *symptomatic;* or no such local mischief may exist to account for the fever, which is then called *idiopathic, primary*, or *specific*.

As examples of the first class, we may cite the rise of temperature which occurs in phthisis, in inflammation of joints, and after surgical operations; under the second class we find most of the disorders commonly known as *fevers*, such as scarlatina, small-pox, and typhoid. It is well to notice that in the course of those *specific* fevers, lesions of various parts may occur, but such lesions follow the primary fever, and depend, like it, upon the introduction into the blood of some morbid poison. The special features of the different diseases which give rise to fever, will be dealt with again, but in the meantime it will be useful to consider some phenomena common to all febrile conditions.

The *temperature* may range from 99° or 100° to 110° or 112°; if it rises above 106° the condition is spoken of as *hyperpyrexia*, and, as a general rule, a temperature above this indicates the greatest possible immediate danger to the patient. Exceptional cases have been recorded where the temperature has reached the extraordinary height of 120°, 124°, and 130°, for a short time at irregular intervals, without being fatal.

The *pulse* is increased in frequency usually in some proportion to the amount of fever; the blood becomes less alkaline, and undergoes other alteratious in character.

The *respirations* are increased in frequency, and the quantity of carbonic acid eliminated is greater than in health.

The *digestive system* is thrown into disorder, the tongue is foul, there is loss of appetite, nausea or sickness, and the bowels are usually constipated.

The urine is scanty, high coloured, and frequently contains albumen.

There is depression of *muscular and nervous activity*; the patient feels languid and unfit for work, the mind is less clear than usual; headache is a frequent symptom, and there may also be aching and uneasiness in different parts of the body.

The great care that Nature takes in health to keep the whole body of one uniform temperature, prepares us in fact to find that when this temperature is exceeded, every function is disturbed, and every tissue suffers more or less from excessive waste and faulty nutrition. Sometimes the onset of the fever is gradual; at other times it is ushered in by shivering, headache, thirst, and general feelings of malaise, and comes on quite suddenly.

SPECIFIC, IDIOPATHIC, OR PRIMARY FEVERS.

There are good grounds for believing that all the so-called specific fevers are due to the introduction into the blood, and the development and growth there, of low forms of life. Although it is perhaps doubtful if the actual germs or seeds of any disease have ever been discovered (except those due to animal parasites), the phenomena of such diseases as small-pox, typhoid fever, scarlatina, &c., are strongly in favour of such organisms being the active agents. In each case we have, after exposure to infection, a more or less definite period of quiescence, analogous to an incubation stage, a period of growth of the disease, a period of maturation and of decay; the disease is capable of reproducing itself indefinitely, and this power of reproduction is favoured by all those circumstances which help the growth of low organisms, and is hindered or stopped by such conditions as are destructive to them. It has been shown that healthy blood has a power of destroying, or rendering inert, certain products which are capable of producing, in less healthy conditions, severe or fatal forms of disease. Again, the concentration of the emanations from diseased persons, by want of venti-

lation and overcrowding, increases the virulence of the poison, while on the other hand free dilution with pure air, or the exposure of the infectious matters for some time to a temperature or an atmosphere destructive to germs of animal plant life, is usually sufficient to destroy their reproductive power.

The specific fevers are generally classified as consisting of *remittent* and *intermittent*, in which the febrile condition ceases partially or altogether for a time, to recommence after an interval; and the *continued*, in which there are no such remission or intermission, which latter class includes the *exanthemata*, or such fevers as are accompanied by peculiar eruptions. It will be convenient to consider the continued fevers first, commencing with the *exanthemata*. The term *zymotic* is often used to describe these diseases on the supposition that the poisons that produce them act in the blood as ferments.

SCARLATINA (scarlet fever).

Causes.—As is the case with the other specific fevers, we may assume, until we have definite proof to the contrary, that this disease always arises from exposure to the infectious matters cast off by some pre-existing case. A previous attack is a protection, but not invariably so, and children are more likely to be affected with it than adults. The contagion is very subtle, and may be spread through the air, through the clothing, and other things which have come into contact with the patient; water, milk, and other fluids and solids used as food, frequently convey the infection. Milk especially has frequently been shown to be capable of spreading the disease through entire districts. Whatever lowers the general health, tends to make the disease more easily and more virulently acquired, and for this reason, probably, attacks of this and of other kindred diseases have often been attributed to bad drainage and other faulty hygienic conditions.

Period of Incubation.—This is usually about five or six days. In some cases it is not more than two days, while in other instances it may be two to four weeks after expoposure to the infection before any symptoms appear. We may here note that the poison has this additional analogy to the seed of a plant, that under favourable circumstances it will retain its vitality for an almost indefinite time; cases are recorded where infected clothing, locked up for many years, has, on being turned out, renewed the original disease in all its intensity.

Symptoms and Course.—The first symptom is usually rise of temperature, with the accompanying general disturbance due to that condition. The pulse is quicker than in the preliminary fever of the other exanthemata, and sore throat is almost invariably complained of. The temperature like the pulse exceeds that of other fevers, and may reach 105°, 106°, or even a higher point; it does not fall with the appearance of the eruption, but goes on rising. Usually about the second day of the fever a scarlet eruption appears on the trunk, forearms, lower part of the abdomen and bend of the thighs, and it may appear twenty-four or thirty-six hours later on the face and neck. This eruption consists of a great number of small closely set papules; by passing the finger or a pencil over the surface the redness disappears for a moment to return again immediately. The appearance of the tongue is very characteristic; on the first day of the disease it is covered with a slimy white or yellow fur, and is red at the tip and edges; on the second and third day the area has increased; and on the fourth day the coating has almost disappeared; the papillæ are raised above the surface, and the whole tongue is swollen; it is at this period that it presents what is called the "strawberry" appearance. The epithelium desquamates, the swelling disappears, and except for increased redness of the mucous membrane, the tongue by the 10th or 11th day is in its natural state. About the same time that we find the typical strawberry tongue, that is from the 4th to the 6th day of the disease, the rash commences to fade from the skin. In favourable cases the temperature now gradually subsides and desquamation of the cuticle commences. This generally begins on the neck and chest, spreads to the limbs, and is longest of appearing and most complete where the epidermis is thickest—namely, on the soles of the feet and the palms of the hands. The desquamation may cease in a few days or go on for weeks. Trousseau mentions a case where it was still going on actively on the thirty-fifth day of the disease, and another in which it was well marked on the 72nd day; both these cases were in adults. Scarlet fever may be the mildest of all disorders in its symptoms, and only the desquamation may call attention to it, or it may be the most virulent of all the fevers. In some epidemics hardly a fatal case has occurred, and in others the disease has been more deadly than typhus or Asiatic cholera. Three varieties of type

are common, and are known as *scarlatina simplex, scarlatina anginosa* and *scarlatina maligna;* in addition, the name latent scarlatina is given to those cases where all the symptoms have been so slight as to be hardly noticed, but for the development of some of the sequelæ to be presently mentioned.

In the simple form of the disease the temperature never rises above 100° to 102°, the pulse is not so rapid as in the severer forms but is stronger, the eruption is slight and soon passes away, and sore throat, although present, is not troublesome.

In scarlatina anginosa, the throat symptoms are often of extreme severity. On examination the tonsils and fauces are found to be acutely inflamed, and muco-pus is often poured out in great quantity from the crypts in the tonsils. The inflammation may take a severely ulcerative form, and from the absorption by the blood or in the stomach of the inflammatory products, symptoms of blood poisoning may be added to those proper to the disease. There is of course great pain and difficulty in swallowing; neighbouring glands are enlarged, and may suppurate; the breathing is interfered with, and the breath is offensive. The temperature is high, and is kept up after the disappearance of the eruption by the local inflammation.

In the *malignant* form of the disease, the patient may die in a few hours from the appearance of the symptoms, which are those of extreme prostration, affecting notably the circulation and the nervous system. No rash may appear, and often the only clue to diagnosis may be the occurrence of associated cases in which the symptoms are allowed to become more developed. The simple form of the disease, and more commonly the anginose variety. may assume malignant characters. In these cases, which may have gone on well to the eighth or ninth day, the pulse becomes very rapid, weak, and irregular (always a most serious symptom in disease), there may be delirium followed by convulsions and coma. The tongue becomes dry and brown, the breathing hurried, the face becomes dusky, and the skin feels cold. The throat may be so much ulcerated and covered with slough as to suggest the idea enunciated by Trousseau, that a diphtheritic attack has supervened on the ordinary membranous sore throat of scarlatina.

The complications and sequelæ of scarlatina are per-

haps more important than those of any other specific fever. During the attack, or afterwards, we may have various lung and heart disorders—as pleurisy (the effusion being frequently purulent), pneumonia, bronchitis, pericarditis, or endocarditis. During the period of desquamation the patient is especially liable to severe inflammation of the kidneys, or desquamative nephritis, one of the commonest causes of acute Bright's disease. The urine then becomes scanty, smoky from the presence of blood, of high specific gravity, loaded with albumen, and showing under the microscopes, blood cells, blood casts of urine tubes, and renal epithelium in great abundance. General anasarca or dropsy may be present to a great degree, and general symptoms of blood poisoning from inefficient elimination of the urinary constituents, may become well marked. The nephritis may become chronic and last for a long time. An interesting condition is sometimes found, in which there is prominent and long-continued dropsy, without the presence of albumen in the urine at any time. If the anasarca affects the mucous membrane about the glottis, the *œdema glottidis* so produced may be fatal. Fatal convulsions, also indicating uræmic poisoning, may also set in.

Scarlatinal patients are also very liable to suffer from articular rheumatism, from inflammation and suppuration of glands in various parts of the body, from inflammation affecting the Eustachian tube, the membrana tympani, and the parts of the middle ear; these latter affections usually give rise to deafness, and may spread to the brain, or may set up pyæmic abscesses in different organs, and thus cause death.

Gangrenous inflammations are not uncommon after scarlet fever in unhealthy subjects; the most frequent form is that which causes destruction of the cheek, and is named cancrum oris. In puerperal women, the poison of scarlatina has frequently been said to cause fatal attacks of puerperal fever.

Treatment.—It is important in all cases that the patient should be kept *in bed* in a well-ventilated room (about 1,500 cubic feet should be allowed for each adult), of a uniform temperature of 60° to 65° Fahrenheit, and that he should be strictly isolated throughout the whole course of the disease. The bowels should be regulated by the giving some mild saline, but it is very doubtful if any drugs have power to modify the disease. To allay thirst

liquids may be given, such as barley-water with lemon-juice, and bits of ice may be sucked. The body should be frequently sponged with some disinfecting fluid mixed with hot water; and during the desquamative period, hot baths ought to be used. It is also a good plan at that period to anoint the body, or part of the body, with carbolic oil, to prevent the escape of infectious scales. Where the nostrils and throat are much ulcerated or sloughing, they must frequently be washed out with solution of chlorine, permanganate of potash, or other antiseptics, or the sloughing surfaces may be treated with strong nitric acid. It is a matter of the very first importance whenever there are any symptoms of failing strength or of a severe form of the disease, to support the patient by good food, which may best be given in a fluid state, as strong beef tea, broths, and milk; stimulants are called for whenever the pulse begins to fail in strength; port wine, brandy and egg mixture, or carbonate of ammonia, may be given. The complication and sequelæ of the disease must be treated as they arise.

MEASLES (*Rubeola, Morbilli*).—Like scarlatina, measles is a specific fever always arising from exposure to the infectious matters thrown off by some previous case. It chiefly attacks children, and one attack is usually, but not always, a protection from others. The period of incubation is about ten to fourteen days, but may be less or more than this. The symptoms which usher in the disease are, rise of temperature, with the accompanying phenomena of that condition, and catarrh of the eyes, nose, and respiratory tract. Frontal headache is a frequent symptom, from the catarrh extending to the frontal sinuses, and bronchitis of the large and small tubes is nearly always present. Rigors (sudden attacks of shivering, with sweating and high temperature) are common, and associated with this condition.

Convulsions, which may be fatal, sometimes occur. On the *fourth* day of the invasion, all the symptoms which during the preceding twenty-four hours may have much abated, become increased in intensity, an eruption appears about the temples and forehead, extending to the cheeks and back of the neck; usually by the following day it has spread to the arms and chest, and then to the body and legs. This eruption is *papular*, dusky red in colour, frequently arranged in little *crescentic* patches which have a tendency to run together, and it is then not

always an easy matter to distinguish it from the scarlatinal rash. In this stage of the disease, diarrhœa is very often a prominent symptom. On or about the sixth day the rash usually begins to fade, and with its disappearance the temperature rapidly becomes reduced, and may sink at once to normal, or may remain for a few days at 100°. The skin becomes rough from slight branny desquamation, but no peeling occurs as in scarlatina. Measles is usually a mild disease, tending to run a definite course and then disappear; but it sometimes assumes malignant characters, being accompanied by hæmorrhages and by symptoms of great prostration—namely, weak rapid pulse, low muttering delirium, and dry brown tongue. The bronchitis and diarrhœa may also be of so serious a nature as to cause death.

Complications and Sequelæ.—The ordinary bronchial catarrh may develop into an acute attack of capillary bronchitis; catarrhal or lobular pneumonia, or ordinary lobar pneumonia, may set in, and any of these conditions may be followed by pulmonary phthisis. Perhaps the most frequent sequela is chronic bronchial catarrh, which is often exceedingly troublesome and intractable. During the course of the disease, inflammation of the ear—otitis—followed by diarrhœa, may come on. In the case of children, intense restlessness, and signs of suffering, with no obvious cause for these symptoms, in the abdomen or chest, are always suspicious of otitis. Diarrhœa may also be a troublesome legacy from an attack of measles. Cancrum oris and gangrene of the vaginal labia are very rarely developed after measles.

Treatment.—The hygienic treatment should be the same as in scarlet fever; and if there is much bronchitis, the air of the room may be kept moist as well as warm by the use of a kettle of boiling water with a long spout, to introduce steam into the apartment. For the convulsions of children the treatment is chiefly expectant, but if there is much spasm of the throat, the assiduous application of hot water by means of a sponge is very useful. The diet should be light but nutritious, and the bowels must be carefully regulated, purgatives, if necessary, being used with great caution. In children, and where there is difficulty of expectoration, emetics may be given. Where the rash shows a tendency to recede too rapidly or come out imperfectly, and the patient at the

same time shows symptoms of great depression, the wet pack, or a hot bath with a little mustard in it, may be tried. Tonics, change of air, and warm clothing are required during convalescence.

German Measles (Rötheln, Rubeola Notha, Epidemic Roseola).—By these names a specific exanthematous fever not uncommon in this country and on the Continent is designated. It may easily, if due care is not taken in the diagnosis, be confounded with measles or scarlatina, and has even been stated by some physicians to be a hybrid disease compounded of those two. There seems to be no foundation, however, for this theory. Rötheln has an incubative period varying from seven to twenty days. The symptoms are those of fever of a mild type, and the eruption appears usually on the second or third day; Trousseau describes it as appearing on all parts of the body, but being best marked on the trunk and limbs. The patches are paler, larger, more distinct from one another, than those of measles, and their appearance is marked by intense itching and burning. They are very fugitive, and may appear and disappear alternately for about seven days. With the disappearance of the eruption, the temperature, never high, subsides, and the patient is convalescent, no complication or sequelæ having to be feared. No special treatment is required. Rötheln may be distinguished from measles and scarlet fever by the history of its course and symptoms.

1. It is not accompanied by catarrh, or much soreness of the throat.

2. It does not protect from an attack of measles or scarlatina.

3. One attack does not protect from another, but has even been said to predispose a person to the disease.

4. Although frequently epidemic, like measles and scarlatina, the symptoms are always mild, and there are no sequelæ.

Rötheln is, however, a disease which still requires careful and extended study. Recent experience leaves it at present doubtful if it is always the innocent disease it has been represented, and the question of the protection afforded by one attack is not definitely settled.

Small-pox (*Variola*).—Small-pox is a specific infectious fever, characterized by the appearance on the skin and mucous membranes of an eruption of distinct raised papules, which in the course of the disease become

pustular. There are two well-marked varieties of small-pox commonly met with: in one the pustules have a tendency to run into one another, and are very numerous; in the other they are fewer in number and more or less widely separated. The former, or *confluent* form, is by far the more serious; the latter, the *discrete* or *distinct* small-pox, is seldom dangerous to life. Sometimes there is a tendency to hæmorrhages into the vesicles, or from the mucous surfaces or into the skin, with from the first symptoms of great collapse, and to this form of the disease the terms hæmorrhagic or *malignant* have been applied on account of the great and early mortality accompanying it.

When the attack is very light, occurring usually in subjects protected by previous attacks or by vaccination, it is sometimes spoken of as *modified small-pox* or *varioloid.* It will be convenient to consider the main varieties of this disease separately.

Confluent Small-pox.—This disease may attack persons of any age or condition of life. Those races of mankind which are brought into contact with any form of the small-pox poison for the first time are peculiarly liable to it; unvaccinated or otherwise unprotected persons are likely to be attacked with it during a small-pox epidemic, and in all cases the mortality from it is high. Like most of the specific fevers, confluent small-pox always arises from exposure to infection. The infectious matter of small-pox is distinguished by its great vitality and by the ease with which it is carried from place to place.

The period of incubation, when the disease is acquired in the ordinary way, is about *twelve* days. There is a well-marked period of invasion, ushered in by shivering, high temperature, pain in the back and loins, often exceedingly acute and depending upon irritation of the spinal cord; this last symptom is nearly constant, and is occasionally accompanied by numbness of the extremities or even by paraplegia. Vomiting is severe and continuous; in children diarrhœa is generally present, and the patient may have well-marked cerebral symptoms—*e.g.*, delirium, convulsions, or coma. Perspiration is rarely abundant, and the temperature is high, reaching 104° or 106°. On the second or *third day* an eruption appears on the skin and mucous membranes, the temperature may fall one or two degrees and the other symptoms abate, but not to the same extent as in the less severe forms of the disease.

Characters of the Eruption.—At first there is a diffuse redness of the skin of the face, which is followed within twenty-four hours by the appearance of papules, closely set, and not so large or so distinct as in the milder forms of small-pox. These papules can often be felt before they can be seen, giving a sensation to the fingers as if small shot were embedded in the skin. The other parts become affected, but as a rule less severely than the face. In the course of a few days the papules coalesce, the epidermis becomes raised in patches of whitish grey colour, filled with a milky fluid, the face becomes swollen, the eyelids closed, and from the eruption attacking the conjunctiva or cornea, there is frequently great sero-purulent discharge from the eyes. From the eleventh to the fourteenth day of the disease the eruption becomes puriform, and then putrescent, the skin presents a wrinkled appearance, and the odour from the patient's body is peculiarly offensive. After this the eruption begins to dry up, and cicatrization takes place, often giving rise to permanent scarring, especially of the face. The itching of the face and other parts is, in the later stages of the illness, always extremely troublesome.

Symptoms accompanying the Eruption.—As has been said, the *temperature* in this form of small-pox only falls slightly on the appearance of the eruption, and rises again, the rise being generally accompanied with cerebral symptoms, when maturation of the vesicles occurs. *Salivation*, often to an enormous extent, sets in early and is a prominent symptom until the ninth or tenth day, when it begins to abate. Succeeding the salivation—on about the twelfth day of the disease—there is *swelling of the hands and feet;* much importance has been assigned to this symptom by Trousseau and other observers, who have pointed out that when swelling of these parts is absent in confluent small-pox, the case is likely to prove fatal. In rare cases critical discharges from the bowels or kidneys may take the place of such swelling, and it is only at this period of the disease—viz., eleventh to fourteenth day—that the constitutional disturbance is generally at its height and the danger to the patient greatest.

Complication and Sequelæ.—In the course of the disease the lungs or pleuræ may be the seat of inflammation. There is very frequently febrile albuminuria. Purulent ophthalmia may come on and result in sloughing of the eyeball; otitis is occasionally found. In children there

may be troublesome diarrhœa; in adults there usually is constipation.

Treatment.—The treatment, in this as in other infectious diseases, consists in providing the patient with pure warm air, light and nutritious diet, rest and cleanliness. The bedclothes and body linen should be very frequently changed, especially during the purulent stage; the body should be sponged frequently with warm water and Condy's fluid. If symptoms of failing strength appear, stimulants should be given. Local application may be used to prevent pitting and to check itching; Carron oil and collodion are frequently used for this purpose. The isolation of the patient and the quarantine of those attending him should be as strict as circumstances will permit. In small-pox epidemics, or on the appearance of sporadic cases, vaccination or re-vaccination is of course the great safeguard againt the disease.

Discrete Small-pox.—This form of the disease resembles the more severe form already described in its general course and symptoms. The invasion period is marked by less severe disturbance, the temperature may only rise one or two degrees, and on the appearance of the eruption usually falls at once to normal, while all the other symptoms subside at the same time. The pocks are larger than in the confluent form, and increase in size until the period of maturation; the centre of each pustule growing less rapidly than the circumference gives to it an umbilicated appearance. As in the severer form, the temperature rises when the pocks become pustular, and the constitutional disturbance is then aggravated. Discrete small-pox is very little dangerous in itself, but it may take on malignant characters, or it may give rise to the confluent form. The treatment therefore should be directed mainly to checking the spread of the disease to others, and to guarding the patient against intercurrent disorders.

Hæmorrhagic Small-pox.—This is the most fatal of all the forms of the disease. There seems to be some evidence that vaccination or previous attacks of small-pox are of little use in guarding against it, and that its peculiarities depend greatly on the constitution of the patient. The period of invasion is usually marked with symptoms of rapid collapse, there may be copious extravasations on the neck, chest, and other parts of the body, with profuse hæmorrhages from the mucous surfaces. No eruption characteristic of small-pox may appear

before death, or there may be a crop of pocks which from the escape of blood into them appear black. It may also be noted that in the confluent or discrete forms of the disease there may be, before the characteristic eruption appears, minute extravasations into the skin (to which the names vibices and petechiæ are applied). Delirium more or less marked is generally present in malignant small-pox. The *treatment* must be directed towards keeping up, in every possible way, the strength of the patient by the free administration of stimulants; and such food and in such quantities as can be assimilated.

Modified Small-pox.—This is really a very mild form of discrete small-pox. The eruption, which is scanty, dries up about the tenth day instead of becoming pustular. The early symptoms are those of ordinary small-pox, and may be well-pronounced or of the slightest possible character. There is hardly any febrile or constitutional disturbance throughout. Without some care in the examination of the eruption and attending to the history and course of the case, it is not difficult to confound this disease with varicella or chicken-pox.

Vaccinia, or Cow-pox.—Vaccinia is a disease affecting cattle, capable of being produced in them by inoculation with the small-pox poison from men, and itself infectious to man by inoculation and otherwise. It is mainly important as a protection against small-pox, of which it is believed to be a mild form.

Symptoms and Methods of Inoculation.—Vaccination or inoculation with the vaccinia poison is usually performed by making a few scratches or punctures on the skin of the left arm, and introducing into the wounded surface lymph direct from the cow, from an infant about the eighth day of the disease, or lymph which has been preserved in capillary tubes or in some other way. On the second or third day a small red papule appears at the vaccinated surface, and the patient has mild febrile symptoms. On the fifth or sixth day, the papule has increased in size, is greyish and depressed in the centre; by the eighth day the papule has become a vesicle filled with clear lymph. This in a day or two becomes purulent, and the whole arm may become much inflamed. A permanent scar is left at the vaccinated spot.

Every one is not susceptible to the vaccine poison, and an attack of small-pox, or of recent vaccinia, either protects against or modifies the influence of vaccination.

Certain dangers in connection with it must not be lost sight of. Syphilis has been introduced through careless vaccination; gangrene of the limb and trunk has followed, or the vaccinated arm has been the seat of severe inflammation. The only treatment called for is protection of the vaccinated part, light diet, and regulation of the bowels.

Varicella, or Chicken-pox.—This is an infectious fever, characterized by the appearance of an eruption, at first papular, then vesicular, and afterwards pustular, on the skin. A modified eruption is also usually found on the mucous membrane of the mouth and fauces.

The period of incubation is about fourteen days; but, as in other diseases, it is liable to variation. The invasion period lasts for about twenty-four hours, and the symptoms then are seldom more than those of slight malaise, but occasionally in children (whose temperature is more easily affected than that of adults) there may be considerable rise of temperature and general constitutional disturbance. Within twenty-four hours after the appearance of symptoms a papular eruption appears on the face, neck, and body, usually scanty in amount. These papules soon become filled with a clear watery fluid, and enlarge considerably; in two or three days they become milky, and then scale and disappear. Occasionally they leave permanent scars. Successive crops of papules having these characters make their appearance for several days, and run the same course.

Occasionally, under bad hygienic conditions, and in weakly or strumous children, this disease takes on a more dangerous character. The vesicles do not scale and disappear, but a sloughy inflammation occurs, which may extend into the true skin and underlying tissues. Troublesome abscesses, or even caries of bone, may in this way follow varicella: the name *varicella gangrenosa* has been given to this variety of the disease.

By some authorities varicella has been considered closely related to, if not identical with, small-pox, but there seems to be little doubt that it does not protect from that disease, and there is no evidence to show that it ever gives rise to it. At the same time, as has been already noticed, when a case of varicella is only seen in one of its stages, it is not always an easy matter to diagnose it from modified small-pox.

Treatment.—No specific medicinal treatment is re-

quired, but patients suffering from varicella should be isolated; and in all cases the patient should have careful diet, strict cleanliness and rest. If there is a tendency to unhealthy inflammation the parts affected should be poulticed, and some stimulating application should afterwards be used; cod-liver oil may also be given.

Typhoid Fever (Enteric Fever).—Typhoid or enteric fever is a disease characterized by a specific inflammation of the solitary glands and Peyer's patches in the lower part of the small intestine, and of the solitary glands in the first part of the large intestine; the morbid products cast off from the diseased surfaces, when introduced into the alimentary canal of other persons, are the means whereby the disease is spread. Peyer's patches and the solitary glands are lymphoid structures connected by lymphatic channels with the mesenteric glands; these latter are also affected sooner or later, and Dr. Klein has shown that the submucous lymphoid tissues of the intestine are affected in a similar way to the solitary glands. Many theories have been advanced in explanation of the intestinal ulcerations in typhoid fever. Fungoid growths have been positively stated to have been seen, and the question has been set at rest more than once, only to be again opened up when such observations were proved to be faulty.

Typhoid fever may attack persons of any age or condition of life, but is rare in persons after middle age, and seems to affect especially those who either from too generous living or tender age have an irritable alimentary canal. The *incubation fever* is stated to be about fourteen days, but in most cases is uncertain. The *invasion stage* may be well-marked or the disease may come on insidiously.

In some instances the symptoms, to be presently described, are so distinct that the disease can hardly be mistaken, in others the course of the disease may be so abnormal or masked by complications, or the symptoms may be so slight, that a correct diagnosis is nearly impossible.

Symptoms.—Frequently during the first week of the disease the patient is able to walk about, but has a feeling of tiredness, both bodily and mental, complains of headache, nausea or sickness, and these symptoms go on increasing day by day. Constipation is very frequent at this stage, and while the patient is drowsy and languid by day, he is restless and irritable at night. The tempera-

ture is above normal, and the pulse is quickened, not, however, very greatly. While the patient is walking about, or doing his daily work, the temperature may be found normal, or even subnormal, while examination at night may show a temperature of 104° to 106° F. If the patient is kept at rest and the disease runs its normal course, the temperature is found gradually to increase until the end of the first week. In many cases there is an almost regular evening rise of two degrees and a morning fall of one degree, making a total daily rise of one degree, until the temperature may reach 104°, 105°, or 106° F. After that, in uncomplicated cases, the temperature shows a steady evening rise and morning fall until towards the end of the disease, when it gradually falls. About the beginning of the second week, in the majority of cases, little red lens-shaped spots appear on the skin of the chest and abdomen, and sometimes of other parts; these lenticular spots disappear on pressure, immediately to reappear; they last two or three days, and are replaced by successive crops until the end of the disease. Diarrhœa is now usually a prominent symptom; the stools may be passed from one to a dozen or twenty times a day, and are well described by the term "pea-soupy." By the tenth day the intestinal lesion has reached the condition of ulceration, and at this time night delirium, of a more or less decided kind, is generally present. The tongue is now coated, often dry and transversely cracked, the patient is thirsty and may have difficulty in swallowing, the face is anxious-looking, flushed at times, at other times somewhat dusky, and the skin, generally dry, may be alternately dry and covered with perspiration.

In very favourable cases the intestinal inflammation may now gradually undergo resolution, the temperature falls, all the symptoms subside, and uninterrupted convalescence sets in from about the end of the third week. In cases which run a more severe course, the serious symptoms of the second week are continued into the third, the weakness of the patient becomes more marked, and what are called "typhoid" symptoms may come on. The term "typhoid" in this sense bears no special relation to the disease we are discussing; the typhoid state may be found in typhus, scarlet fever, and in other conditions of depression from some intense morbid poison. It is characterized by a pulse of great frequency, weakness, and perhaps irregularity; there may be low muttering

delirium, with twitching of the tendons of the hand (subsultus tendinum), clutching or picking at the bed-clothes, and great general restlessness; the motions are frequently passed involuntarily; the tongue is coated with a dry brown fur, the teeth are glazed and covered with sordes, and the face has a dusky aspect, and an anxious expression. This condition is usually the fore-runner of death.

In less serious cases the symptoms generally commence to subside on the twenty-first or twenty-eighth day. The temperature falls at first only in the morning, rising again at night, but gradually both morning and evening temperature are reduced to normal, or fall below it. Such a gradual defervescence or termination of fever is spoken of as a "lysis," in contradistinction to a "crisis," where the temperature falls suddenly.

Complications and Sequelæ.—In all febrile states it is well to remember, as we have already stated, that the protoplasm of every part of the body is existing under unnatural and disturbing conditions; a persistent high temperature must mean excessive waste of tissue and disturbance of function in every direction. In addition, however, to this general disturbance, we have special dangers in connection with typhoid fever. *Pneumonia* may attack one or both lungs; it may come on early, or more commonly towards the end of the disease, and is predisposed to by the hypostatic congestion which the lying posture, the relaxed condition of the lung tissues, and the poisoned blood, all have a hand in producing. Other forms of lung trouble also are not infrequent.

Perforation of the intestines, leading to peritonitis, or to immediate collapse and death, may come on in the second or third week, or later. In some cases of typhoid this accident may be the first notification of the presence of disease. The patient may have been attending to his usual duties, when he is suddenly seized with intense pain in the abdomen, symptoms of collapse come on, and death may ensue in a few hours. In other cases, perforation occurs in the course of a well-marked attack of fever, and here the symptoms may be marked or very declared. In the latter case the temperature falls suddenly, the pulse becomes rapid and weak, and if death does not follow quickly peritonitis sets in. Usually there is great and sudden pain complained of in the abdomen. In other cases, where the perforation does not occur sud-

denly, peritonitis is set up, which glues the coils of the intestine together, so that when the gut gives way the contents of the intestine are prevented escaping into the peritoneal cavity. Here the temperature may have no marked fall, but low typhoid symptoms set in, the abdomen is tender and swollen, and death usually follows within a few days.

Peritonitis occurs in some cases of typhoid without perforation preceding or following it. In such cases recovery is not improbable, but there is always great difficulty, if not impossibility, in deciding during life as to the absence of perforation.

Hæmorrhage from the bowels often occurs during the second or third week. It is due to the ulceration opening some blood-vessels, and may be slight or so great as rapidly to destroy life. The blood usually appears in the motions, but if there is constipation, may be retained in the bowels. The temperature falls if the hæmorrhage is copious, the pulse becomes soft and compressible, the patient is anæmic, and his weakness is increased.

In other cases there may be general hæmorrhage from mucous membranes; this is one of the most serious of complications.

Bed sores may appear over the sacrum or other part of the back, or on the heels in the later stages of the disease.

Relapse in typhoid, although not strictly a complication, may be conveniently mentioned here. In this respect typhoid fever differs from those specific fevers previously considered. It is of very frequent occurrence that, when the symptoms have apparently entirely subsided and convalescence has set in, the whole train of symptoms will reappear, and the disease may then run a long and tedious course. Whether the relapse is due to errors of diet or to local contagion from unavoidable causes is doubtful. Not only one, but several relapses may follow an attack of typhoid fever. A return to a higher temperature during lysis is called "recrudescence."

When convalescence is fairly established, the patient will always be found much weakened. The muscles are atrophied, and have undergone more or less fatty degeneration. Atony of the bowel is one result of this, and assimilation of food is imperfectly carried on. Constipation is frequently present and very troublesome, but sometimes diarrhœa and vomiting may be present to an

alarming extent. The mesenteric glands which have been much enlarged during the disease do not quickly return to their original condition, and thus present an obstacle to the passage of food from the lacteals to the thoracic duct. The mental faculties remain more or less dulled for some time; it may be for eight months or a year after the illness.

Treatment.—One of the main features in bringing about the recovery of the patient is the early recognition of the disease and rest in bed from the first; another equally important point is the maintenance of the patient's strength by proper food. Beef-tea, light soups and milk, are the most suitable articles of diet. In giving milk caution should be observed, as it frequently happens that curdled milk gets into the diseased intestine and gives rise to much irritation. If the patient does not do well on milk diet this should be left off and strong beef-tea or beef essence chiefly used.

The temperature of the sick-room should never be allowed to fall below 60° Fahr. The body should be frequently sponged with tepid or cold water; the mouth should be washed out with some antiseptic solution at intervals, and ice may be sucked or fruit juice sipped to relieve the dryness and discomfort of the tongue. The chest and abdomen should be frequently examined for signs of complications, and the bladder if necessary should relieved by the use of the catheter. If there is excessive diarrhœa, opium may be given by the mouth or by enemata; astringents of various kinds may also be used, as gallic acid, alum, lead, &c. For hæmorrhage, gallic acid may be given by the rectum; turpentine in fine medium doses frequently repeated has been recommended, and ergotine, injected hypodermically, may be used. Quinine in large doses is much used by some practitioners to reduce temperature. Alcohol is called for in the later stages of the disease, or if the pulse becomes weak and irregular. If perforation should occur, the only hope of saving the patient lies in giving large doses of opium.

TYPHUS FEVER.—Typhus fever is defined by Dr. Murchison as "a disease attacking persons of all ages, generated by contagion, or by overcrowding of human beings, with deficient ventilation, and prevailing in an epidemic form in periods or under circumstances of famine and destitution."

The same disease has been known as jail fever, malignant hospital fever, camp fever, &c., from its places of origin, but in our day it is almost never met with, except in connection with the overcrowded houses of the poor, and is always spoken of as typhus fever.

Causes.—There seems to be abundant evidence that typhus fever can be generated by bad hygienic conditions, and once started, that it spreads quickly by contagion, more especially to those brought into immediate contact with the patient, and who are ill-fed or exhausted.

Symptoms.—The incubation period is generally about nine days, but may range from only a few hours to fourteen or fifteen days. At first the patient is seized with slight rigors and feels languid and indisposed to exertion of any kind. There is headache and dulness of mind with pains in the limbs. The pulse is from 100 to 120, the temperature is 103° or 104° F., and the respirations are slightly increased. The face becomes dusky, the conjunctivæ are suffused, and the eyelids swollen. The tongue is at first white and coated, afterwards becoming yellow. The bowels are constipated, and there is an abdominal tenderness or tympanites. Loss of muscular strength is very rapid, and the patient soon becomes completely prostrate. Sleeplessness and general restlessness become very marked, and there is constant headache; about the fourth or fifth day the characteristic mulberry rash generally makes its appearance on the abdomen, spreading from thence to other parts of the body. The spots are dark-red in colour; some are slightly raised above the skin, while some are subcuticular, giving rise to a mottled appearance. These always remain throughout the disease, and do not, as in typhoid, appear in successive crops. Sometimes these spots become petechial (that is, they become the seat of minute extravasation of blood).

At the beginning of the second week the constant headache gives place to delirium, which may be noisy or of a low muttering character. It is at this time that fatal accidents frequently happen from the patient getting out of bed and throwing himself out of windows, climbing over walls, &c. This violent state is quickly followed by collapse. The tongue becomes curled up in the mouth in a hard dry lump, sordes collect on the teeth, and the bowels continue constipated. The general symptoms become intensified day by day. The eyes may be open

or closed, the tendons of the hand start, there is picking of the bedclothes, and nearly complete unconsciousness of surrounding things. The urine and fæces may be passed involuntarily or may be retained. The pulse ranges from 120 to 150, and is small, weak, and intermittent. Bed sores are especially liable to form over the sacrum and other points of pressure. The temperature is high, but not necessarily so, and towards the end of the disease usually falls to normal, or even below it. If the case is going to end favourably, on or about the fourteenth day the patient falls into a deep sleep, from which he wakes bewildered and weakened, but quite sensible. The tongue is now clean and moist at the edges, the pulse is stronger and slower, and there is some appetite for food. Convalescence sets in rapidly, and no evil effects remain behind. Occasionally typhus may be prolonged to the third week.

Relapse is hardly known in typhus. The symptoms are not always so acute as described, but may be comparatively mild throughout. Although one attack is a protection, it is not completely so, and nurses and others attending such cases frequently have the disease more than once, or suffer from headache, rise of temperature, and general discomfort whilst nursing typhus cases.

Complications and Sequelæ.—Laryngitis, bronchitis, pneumonia, or pleurisy, may accompany typhus, and prove fatal. When bleeding was much in vogue a condition resembling phlegmasia dolens of the leg was not infrequent, but is now seldom seen. Scurvy has been noted in some cases. Gangrene of different parts, more especially over points of pressure, giving rise to bed sores, is very frequent, and buboes, as in plague and erysipelas, sometimes occur. Convulsions coming on during the disease are of very unfavourable import; other nervous affections may supervene, and occasionally the mind remains permanently impaired. Albuminuria occurs in a large number of cases.

Treatment.—As the generation of typhus may be prevented by fresh air and cleanliness, so when the disease has to be dealt with these are the chief factors of treatment. From 1,500 to 2,000 cubic feet of air should be allowed to each adult; and the body should be frequently sponged with tepid water mixed with a little Condy's fluid. Nourishment must be given regularly and sufficiently, but not to excess. Alcohol should be given with

care, watching the pulse and cerebral symptoms, and stopping the alcohol if there is any increase in delirium or in the rapidity of the pulse. The mineral acids, quinine, iron, &c., may be given with advantage, and the various complications must be treated as they arise.

For the prevention of the spread of the disease patients affected should be carefully isolated; all clothing or other articles coming from the sick-room should be disinfected. Exposure to heat for some time, free exposure to air, or steeping in disinfecting solutions, are effectual methods of destroying typhus germs. Nurses should be chosen who have already had the disease, and all who are brought into the neighbourhood of the contagion should live well, and have due amount of rest and exercise.

Asiatic Cholera.—Asiatic cholera is usually epidemic, although sporadic cases occur frequently. The chief determining causes of cholera epidemics are: (1) the coming together of large numbers of people without efficient sanitary precautions; (2) a warm climate.

Experience of the disease in this country has shown that cholera is not communicable directly from person to person, but that it is conveyed, like typhoid, through water contaminated with cholera stools. Experiments on animals have shown that the freshly-passed stools are comparatively harmless, but acquire virulence on being allowed to stand; this virulence is at its height (under favourable circumstances of temperature and moisture) on the third day, and thereafter declines. Individuals of both sexes and all ages may be attacked.

Symptoms.—The course of the disease may be traced through three stages:—

1. The stage of invasion.
2. The algide or cold stage.
3. The stage of reaction.

Death may occur at any period of the disease; convalescence in hot climates is said to follow the second stage without any distinct period of reaction.

The incubation period is doubtful, and may vary from a few hours to some days. The illness is most commonly ushered in by diarrhœa and general malaise. During epidemics the patient is often seized with a great fear of cholera and dread of death. After a few hours, or perhaps days, in this condition there is a copious evacuation of the bowels, followed by constant diarrhœa, the matter discharged being at first coloured with bile, but soon

becoming colourless and assuming a characteristic "rice-water" appearance. Vomiting also sets in, and with the loss from the body of so much fluid in abnormal directions, the skin and kidneys cease their functions; no urine is secreted, and the skin is dry and cold. The algide or collapse stage is a necessary result of the copious watery diarrhœa. Severe cramps in the various muscles of the body and limbs set in. The skin becomes shrunken, livid and cold, the arteries can scarcely be felt to pulsate, the veins and capillaries shrink so that the patient looks like a corpse. There may now be clammy sweats, and the surface temperature may fall eight or ten degrees below the normal; at the same time in the vagina or rectum there may be a temperature of above 100°.

If the patient is going to recover the skin gradually resumes its warmth and colour, the diarrhœa ceases, bile appears in the motions, urine is passed in small quantities, and the patient is able to retain small quantities of food in his stomach.

In some cases of cholera the patient may die at the beginning of the attack, before the development of the characteristic diarrhœa. These cases may be explained by supposing that an unusually large and virulent dose of the infecting material has entered the body. We find analogous cases in epidemics of small-pox, scarlet fever, &c.

Treatment.—There is no specific for cholera, and when the disease is declared it should be left mainly to Nature. Iced water in small quantities may be given to relieve thirst, and the muscular cramps may be treated with friction and hot applications. When reaction sets in small quantities of nourishing food in a liquid form should be carefully given, and the kidneys should be encouraged to act, not by diuretics, but by cupping or hot applications to the loins. The warm or vapour bath is useful in various stages of the disease. Great care should be taken to disinfect the stools of the patient, and whenever there is an epidemic of cholera, it may be taken as a useful rule, *that the drinking water is infected and is the mainstay of the epidemic.*

Much stress is laid by some physicians on the necessity of checking all attacks of diarrhœa during the prevalence of cholera, and no doubt if every case of diarrhœa cured is set down as a case of cholera cut short, the statistics will prove excellent; but all evidence, notably those cases of sudden death without any diarrhœa, shows that cholera

depends on the presence in the blood of a virulent morbid poison, and that it is not to be cured by attacking any of its premonitory symptoms.

Yellow Fever.*—*Causes.*—Yellow fever is wholly a disease of tropical countries. It flourishes most when the temperature of the air is about 75° to 77° Fahrenheit, and is inactive when the average temperature is below 70°, or in places 2,000 to 3,000 feet above the level of the sea. In the West Indies it is usually most active in the months of February and March, and according to some observers the electrical condition of the atmosphere has some influence in its spread. During and immediately after storms the numbers attacked increase, and the symptoms of those already attacked become more grave. A low-lying swampy locality, crowded districts, and bad hygienic conditions, are causes predisposing to epidemics. Europeans newly arrived in infected districts, intemperate persons, those exposed to fatigue and night air, and children, are easily attacked. There is no doubt that yellow fever spreads by infection through water, food, and fomites. As to the active agent of the infection, Dr. Freire, of Rio de Janeiro, claims that he has discovered in the blood and tissues of those affected bacterial organisms, which he has successfully cultivated in organic infusions, and that the phases of their existence coincide exactly with the phases of yellow fever.

Symptoms.—The incubation period of yellow fever is from one to three days. It is ushered in by frequent intense rigors; the temperature may during these rigors reach 104° to 107°. There are articular pains, headache, and symptoms pointing to congestion of the lungs and face; the appearance of the face indeed has been described as typical of the disease, resembling that of a drunken man before the stage of collapse. Thirst, delirium, vomiting of yellow matter, constipation, and albuminuria then mark the progress of the disease for the next few days (usually three or four), and this period, including the invasion, represents the *first stage of yellow fever.*

Second Stage, or Period of Remission.—As the first period is marked by all the symptoms of virulent inflammation, the second is marked by extreme depression. The pulse becomes slow, and the temperature falls, perhaps even below normal. But serious symptoms are not

* Mostly taken from a work on Yellow Fever, by Dr. Freire, of Rio de Janeiro.

wanting; there may be hæmorrhages on the mucous surfaces or into the lungs, oppression at the epigastrium, and a yellow colour of the skin. Sometimes there is much mental lethargy. This stage may last only a few hours, or two or three days, and may be followed by recovery or by a fresh outbreak of bad symptoms.

Third Stage.—Uncontrollable hæmorrhages, a weak and thready pulse, delirium, and all the symptoms of collapse mark the period of the disease. Jaundice becomes more marked; there is frequent vomiting, the colour of the ejected matter becoming dark—the black vomit—the urine becomes suppressed, coma comes on, and then death. The duration of this stage varies with the powers of individual resistance, the nature of the epidemic, and other accidental circumstances.

Benign attacks of yellow fever are not uncommon, and different epidemics have very different rates of mortality.

Treatment.—Hot drinks and warm applications to encourage the action of the skin are recommended in the first stage, and a stimulating and supporting treatment is required throughout, but more especially in the second and third stages. Dr. Freire has lately treated his cases with hypodermic injections (from 4 to 20 grains in water) of salicylate of soda, every four or six hours. This treatment, he says, has been marvellously successful when used in the first and second stages of the disease, along with tonics and good nourishment. In the collapse stage and in the malignant forms of the disease no treatment seems to hold out much hope of success.

Plague.—This disease in modern days is known mainly from its effects in Eastern countries. An outbreak occurred in Astrakhan in 1878 and 1879, which has been investigated and reported on by Mr. J. Netten Radcliffe, and from his report the main causes of the disease seem to lie in the filthy habits of the people, and their poverty and want of proper food, causes which were probably in operation when the plague was a European disease. The symptoms of the disease are violent frontal and temporal headache, pains in all the limbs, shivering, preceded by burning heat in the face and eyes, distended abdomen, enlargement of the liver, and a pulse of 100 to 120. These symptoms tend to recur in paroxysms every two or three days, and are accompanied by delirium and sleeplessness. In some cases abscesses, swellings of the lymphatic glands, and a peculiar eruption appear on the body, but not in

all. The disease at first, as it appeared in Astrakhan, was not acutely infectious, but afterwards became so—a growth of disease which is found in pyæmia, which increases in virulence as it is transferred from one person to another.

Treatment.—Isolation of patients and quarantine of suspected persons and places are the measures which have been successful in checking the spread of the disease. The patients should be placed under the best hygienic conditions possible.

Relapsing Fever (Famine Fever).—This is an epidemic infectious fever, found to arise in seasons of scarcity, associated with a specific organism in the blood—the *Spirillum Obermeieri,* and spreading thereafter to all classes. Relapsing fever has an incubation period of from two to sixteen days. It usually commences with rigors and pains all over the body, with much heat of skin and general malaise. The temperature remains high for five or six days, then generally a profuse sweat sets in, the temperature falls, and except for some weakness the patient is apparently quite well. Usually, at the end of a fortnight, a second attack takes place similar to the first, and lasting two or three days. A third paroxysm sometimes follows. Complete recovery is the rule, but occasionally low muttering delirium comes on with typhoid symptoms, and the disease proves fatal.

Treatment.—The patient should be isolated, kept warm, and supplied with nourishing food. During the fever, sponging of the face and body is grateful to the patient. The bowels should be kept open, and opium or chloral may be given to promote sleep.

Diphtheria.—Diphtheria is an acute specific disease, very infectious, and marked by severe constitutional symptoms, local inflammations. and well-defined sequelæ. It usually occurs in an epidemic form, and is spread by direct contagion, fomites, milk and water. The incubation period is uncertain, and probably variable; it may be only a day or two, or may extend to ten days or more. The premonitory symptoms are sometimes marked by depression and fever, or the disease may be insidious in its onset and unnoticed. The special characteristic of the disease is the occurrence of inflammation of some of the mucous membranes. The back of the throat and tonsils are most usually attacked. They are at first congested and painful,

but soon become covered with greyish-white membranous patches, difficult to remove, and which leave a bleeding surface when they are torn away. The neighbouring lymphatic glands become swollen and painful. There is cough, secretion of tenacious mucus, and dyspnœa. Various forms of diphtheria are described: thus, the disease may be mild and harmless all through, inflammatory symptoms may predominate, the nasal mucous membrane may be extensively affected (Trousseau says that in his experience of French epidemics the nasal form was invariably fatal), the larynx may be first attacked —the primary laryngeal form or true croup, according to some—or the disease may from the first be marked more by constitutional symptoms of an intensely malignant type than by its local characters. Sometimes the vagina is the seat of diphtheritic inflammation, and blistered surfaces or wounds have often been attacked.

In a very large number of cases, besides the local distress accompanying the inflammation, albuminuria is present, the temperature is high, and the pulse quickened. The disease may last only a few days, or go on for two weeks or more. The rate of mortality varies much in different epidemics. In the malignant type death may occur in a few hours, and even when the disease is mild in its onset dangerous symptoms may at any time arise.

Treatment.—The patient should be kept in a warm moist atmosphere. Locally, antiseptic gargles or sprays should be frequently used, and a spray of pepsin solution has been found useful for its action in dissolving the diphtheritic membrane. Much difference of opinion exists as to the usefulness of strong caustics to the inflamed surfaces. When the throat or larynx are affected, the question of tracheotomy will often arise. If dyspnœa becomes excessive, and life is obviously endangered from this cause, the operation must be performed. During convalescence tonics and change of air are needed.

All through the disease great care is required to prevent the spread of the infection. All secretions from the mouth or nose should be at once disinfected or received on rags and immediately burned.

Sequelæ.—During convalescence various forms of motor and sensory paralysis are common. The velum pendulum palati as a rule is first affected; other throat muscles become affected, and general paralysis may set in. The

senses of sight, smell and hearing are frequently affected. Usually, as one part of the body is affected, others are recovering, and the tendency is towards complete recovery. Albuminuria of a chronic kind sometimes remains behind after diphtheria.

Hooping-cough (*Pertussis*).—Hooping-cough is a disease mainly confined to children. It begins in the majority of cases with catarrh of the air-passages and cough, which speedily assumes a paroxysmal character, being especially worse towards evening. The hoop may appear within a week of the catarrh, or not for twenty or thirty days; this is a long-drawn sonorous inspiration which comes on at the end of a paroxysm of coughing. Sometimes hooping-cough commences with fever and the symptoms of acute bronchitis. When hooping-cough is well-established the patient is attacked at more or less frequent intervals with fits of coughing made up, says Dr. West, of short hurried expirations so forcible, and succeeding each other with such rapidity, that the lungs are emptied to a great degree of air and the child is nearly suffocated. The period of continuance of the disease is very uncertain. It may run on for ten or twelve days, or may disappear and reappear at intervals for many months. Hooping-cough, or rather its complications, may be reckoned among the most fatal of children's diseases, death usually being caused by bronchitis, pneumonia, or congestion of the brain.

Treatment.—In the early stages of the disease the patient should be kept in a warm room, and a little ipecacuanha and laudanum may be given to allay the cough; when the hoop appears, dilute hydrocyanic acid may be given in one- or two-minim doses; this is very highly spoken of by Dr. West. Belladonna, bromide of potassium, chloral, and other sedatives are sometimes useful, but in many cases no treatment is of any use. As the patient recovers change of air is advantageous, and care should be taken to prevent chills, indigestion, or over-excitement. The complications must be treated as they arise.

Influenza (Epidemic Catarrh).—Influenza is apparently a contagious disease; it travels from one district to another, rarely being localized for more than a few weeks, and although it spreads rapidly it is remarkable for not being inoculable; for this reason it has been suggested that the influence which produces it is possibly malarial,

or depends upon some peculiar electrical conditions of the atmosphere. The latter consideration is one which has only recently been investigated, and from observations made in America there seems to be some reason to believe that "electric storms" have a connection with various forms of disease.

Influenza has a short latent period, probably three or four days, and is ushered in by febrile symptoms, depression, pains in the limbs and body, with inflammation of the mucous membrane of the eyes, nose, pharynx, and air-passage. Distressing pain is often complained of in the region of the frontal sinuses and in the eyeballs; a troublesome cough is usually present early, and is soon accompanied by thin muco-purulent expectoration and by catarrh of the eyes and nose. The disease may last from two or three to ten or twelve days.

Treatment.—No active treatment is called for. The patient should be confined to bed in a warm room, and if there is much depression stimulants may be given. To relieve the frontal headache hot sponging may be tried. Various drugs are more or less useful. Opium and ipecacuanha in small doses may be given, and Dr. Riagle recommends tincture of actæa racemosa in five-minim doses as a valuable remedy.

Mumps (*Parotitis*).—This is an infectious disease, commonest in children, but not unknown in adult life, which is characterized by an acute inflammation of one or both parotid glands. The incubative period of the disease is probably about fourteen days, and the invasion stage is ushered in by febrile symptoms, the temperature sometimes rising four or five degrees. The submaxillary glands are frequently affected in turn; and occasionally, in the male, there is a disappearance of the parotitis and a sudden appearance of inflammation in one or both testicles. This complication is often followed by atrophy of the testicle affected. The whole disease is usually over in a week or ten days, and there are rarely any grave complications.

Treatment.—The patient should be isolated for the sake of other people, and warm applications should be applied over the swollen and painful glands. Liquid diet must be given, and the bowels should be kept freely open. Grey powder, in doses of one-third of a grain three times a day, is said to relieve the pain and swelling.

INFECTIOUS DISEASES FROM ANIMAL POISONS.

Under this heading may be included Hydrophobia, Glanders, and Splenic Fever.

Hydrophobia, or Rabies.—This disease is produced by the inoculation of salivary matter from a dog, cat, or other animal suffering from rabies, and is usually produced in persons who are bitten by such animals. The incubation period is very uncertain, symptoms sometimes appearing in a few days, sometimes not for many months. When the disease declares itself the patient is at first extremely depressed, anxious, and irritable. In a few days he becomes excited, and perhaps almost maniacal. The mouth and fauces become congested, and secrete tenacious mucus, which the patient has difficulty in getting rid of. Attempts to swallow fluids give rise to painful spasm of the glottis. General hyperæsthesia becomes very marked; convulsions, tetanic in character, are set up by the slightest irritation of the senses of touch, sight, or hearing. The patient's agony is now generally very great, and he gives utterance to distressing cries. His strength rapidly fails, and death occurs in two or three days. The only morbid appearances discovered have been congestion of the fauces and air-passages, and of the nervous centres.

Treatment.—The only sure way of avoiding infection after a bite from a rabid animal is to excise and cauterize the wounded part. Once the disease is declared, no method of treatment has been successful. It is well to bear in mind that the disease is not always inoculable; in only about one or two in twenty cases of bites from rabid animals does hydrophobia ensue. Also, the suspected animal should not be killed until its madness is placed beyond suspicion; nervous subjects may suffer to an alarming extent merely from the fear of hydrophobia.

Glanders, Farcy.—This disease is communicated by horses to men. Its incubative period is uncertain, and its invasion is marked by febrile symptoms and signs of inflammation about the nose and air-passages. Nasal discharge—at first watery, later thick and puriform—follows, and the skin becomes the seat of an eruption consisting of tubercular masses (farcy buds) of the size of a pea, or bigger, which ulcerate and slough. If the

poison has been introduced by a wound of the skin; the nasal symptoms may not be prominent. The term farcy is sometimes used to describe this particular condition, Glanders being applied to the nasal form of the disease. glanders may be acute or chronic. The acute form is nearly always fatal, but patients sometimes recover from chronic glanders.

Treatment.—The nostrils and fauces should be cleansed by the use of Condy's fluid or other disinfectants, and stimulants should be freely given. No medicinal treatment has hitherto been successful.

Splenic Fever.—This disease has been of late years extremely fatal in some parts of Europe among both men and animals. It is usually epidemic, and in this character we seem to have one variety of it in the wool-sorters' disease, common in Bradford and elsewhere. The main symptoms of the disease are headache, depression, sickness, nervous excitement and fever, with a tendency to herpetic eruption and boils. The disease usually runs its course in six or eight days, is generally fatal by that time, but may be fatal at a later period from lung or other complications. Wool-sorters get the disease mainly from the wool plucked from dead sheep, and it has been shown that the agent producing the infection is a bacterium to which the name *Bacillus anthracis* has been given. This bacillus grows and reproduces its species in the blood and tissues of those attacked.

Treatment.—The main duty of medicine here is to prevent the spread of the disease, as once it is contracted drugs have little effect. The strength of the patient should be kept up as much as possible, and probably quinine or salicylic acid may be of some use.

Syphilis.—Syphilis is an infectious disease usually conveyed by direct contact from one individual to another.

It may be considered in relation, 1st, to its local or primary effects; 2nd, to its secondary and remote or tertiary effects; 3rd, to its effects on the offspring of syphilized persons.

Primary syphilis is usually manifested by the appearance of a hard chancre on the part exposed to infection, in from ten to forty days after exposure. This chancre first appears as a red papule, which gradually ulcerates, becomes hard in the edges, and sets up a slight amount of irritation in the neighbouring lymphatic glands. The

chancre slowly heals, leaving behind it a permanent sore or discoloration. This stage of the disease is often not detected, or possibly is often not present.

The second stage or secondary symptoms come on usually in six or eight weeks, but may be delayed. Here, as in the specific fevers, the patient often suffers from febrile symptoms, sore throat and a skin eruption varying much in character, and affections of the mucous membranes. The skin eruption is usually roseolar at first, but may become tubercular, leprous, serpiginous, &c. Pains in the head and joints are common, and the hair becomes dry and falls out. Another symptom often present at this stage is iritis, accompanied sometimes with retinitis, much pain and photophobia. This stage may last for weeks or months: the patient may suffer much loss of strength although his general health may be but little affected.

The tertiary effects of syphilis may never be manifested, may appear in a few months, or may lie latent for many years. Indulgence in alcohol to excess, or any cause which lowers the general health, favours the appearance of tertiary symptoms; these are very various, and any part of the body may be affected. The most striking symptoms are produced by the growth of gummata, which are new growths composed mainly of small cells freely supplied with blood-vessels, and which have a tendency to ulcerate. They may occur in any part of the body. Another striking group of symptoms is produced by fibroid thickenings, which are especially liable to occur in connection with bone, nerves, muscles, and the capsules of internal organs. Thickening of the inner coats of arteries from the deposit of an imperfectly fibrillated tissue is also common.

The symptoms produced by these changes include ulcerations of the skin and mucous membranes (not symmetrical, as in secondary syphilis), skin eruptions, necrosis of bones, especially of the head and face, various forms of paralysis, epileptiform convulsions, apoplexiform attacks, &c.

Effects on Children.—Syphilis often kills the fœtus in utero and produces miscarriages in pregnant women. Children may be born alive either prematurely or so ill-developed that they die soon after birth; in the latter case they look wizened, shrivelled up and puny, and may be covered with a coppery-coloured eruption.

Oftener a child is born apparently healthy, but within a month or six weeks—rarely later—snuffling is noticed from coryza or inflammation of the nostrils, and difficulty in sucking. The symptoms may cease here, but generally eruptions appear on the body, especially about the buttocks. The child's voice becomes hoarse and weak from the accumulation of nasal discharges and ulceration about the mouth. There is progressive emaciation, diarrhœa and weakness, until, if the disease is unchecked, death occurs from inanition. Lung mischief is often set up, either tubercular or pneumonic. If the child lives, other symptoms may come on later in life. When the permanent teeth appear the incisors are often notched, the canines peg-shaped and imperfect. About the same time interstitial inflammation of the cornea may come on, blinding the patient, by causing opacity. The bones may be affected, in some cases becoming so brittle as easily to be fractured.

Treatment.—In children syphilis is most successfully treated by inunction, night and morning, of mercury ointment, or by the internal administration of small doses of grey powder or calomel.

In adults, syphilis must be more cautiously treated, as the free exhibition of mercury in debilitated subjects may produce evils as serious as the disease itself. Every endeavour should be made by generous diet, fresh air, and temperance to improve or keep the patient in good health. Mercury may then be given until the gums are tender. Sores may be treated locally with black wash or mercurial gargles, according to their situation. In secondary or tertiary syphilis, iodide of potassium is generally invaluable. It may be given with cinchona or other tonics in doses varying from three to forty grains or more, three times a day. In cerebral syphilis it is especially useful, and may have to be given in the largest doses.

Idiopathic Erysipelas.—Erysipelas is a constitutional disease characterized by much fever, and by the occurrence of acute inflammation of the skin in some parts of the body. It frequently occurs in connection with local injuries, and that form is treated of in surgical works under the name of traumatic erysipelas.

Causes.—Like the acute specific fevers it may be due to infection. Women and infants are more prone to the disease than men; like rheumatic fever, one attack predisposes to another, and certain families seem to be easily

attacked by it. The exciting causes, besides direct infection, are exposure to cold air while heated (especially in the case of menstruating women), errors of diet, mental excitement, and local injuries, particularly about the head.

Symptoms.—After an incubation period, which may vary from a few hours to two or three weeks, the disease is usually ushered in by rigors and the ordinary malaise of fever. There is a feeling of tension and tingling at the place about to be attacked, the skin becomes red, swollen, glazed, and very tender to the touch. The temperature may rise as high as 105° or 106°, the pulse is correspondingly increased, the tongue is coated, and the bowels are constipated. There is a tendency for the inflammation to be symmetrical, and there is a special tendency for erysipelas to commence at muco-cutaneous surfaces. Especially around the nose is idiopathic erysipelas likely to occur. When the face is attacked the eyelids get much swollen, so that the patient is unable to see, and as the disease advances all the affected parts may swell enormously. In several cases bullæ (large blisters) form, and the subcutaneous tissue may suppurate or undergo gangrene. Where the disease is epidemic it sometimes becomes exceedingly fatal, but, like all other specific diseases, it has a great range in the intensity of its symptoms. Much prostration may come on and be fatal to the patient, or the disease may affect internal parts, such as the brain, pharynx or larynx, and thus destroy life. The course of erysipelas is irregular, but amelioration of the symptoms is often noticed about the sixth day.

Treatment.—Careful and regular administration of nutritious food and stimulants is essential from the first. The perchloride of iron in large doses (30 to 40 minims) may be given every one or two hours. Belladonna and aconite are also useful internal remedies. Locally, the affected parts should be excluded from the air by coverings of flour, cotton-wool, &c. To ease the pain, hot fomentations, with or without opium or digitalis, are often needed. To check the spread of the inflammation, iodine, nitrate of silver, or sulphuric acid, may be painted on the skin. Where there is deep-seated suppuration, free incisions are necessary, and if the throat is attacked laryngotomy may have to be performed. The bowels should be well opened by saline aperients from the commencement of treatment.

Pyæmia and Septicæmia.—Pyæmia is an infectious fever which attacks patients who are suffering from open wounds, ulcers, &c., and women in the puerperal state. Its chief features are, the occurrence of rigors with high temperature and profuse sweating, and the formation of abscesses in various parts of the body. The disease may be acute, subacute, or chronic, and is very fatal in its results. The patient rapidly loses strength, the body wastes, the tongue becomes foul, sordes fill the mouth, and low typhoid delirium comes on. Pyæmia is especially likely to appear when many patients with open wounds or many puerperal women are crowded together; the disease is carried by the air, by sponges, instruments, clothing, and the hands of surgeons and attendants. It clings to beds and bedding, floors and walls of hospitals and private houses, with great tenacity.

Septicæmia is an accompaniment of pyæmia, but may occur without the formation of abscesses, characteristic of that disease. The symptoms are in the main those of pyæmia. Bacterial organisms undoubtedly play the chief if not the essential part in producing pyæmia and septicæmia, but a vigorous condition of the blood and tissues minimizes the effect of these poisons. The term pyæmia is so far misleading, as pure pus itself will not, when introduced into the circulation, produce pyæmia.

Treatment.—It is essential that a very free supply of pure air be supplied to every patient, and that isolation be perfect for the sake of others. The use of quinine in full doses brings down the temperature, but medicinal treatment is not satisfactory. Abscesses when superficial should be opened, and local wounds should be carefully kept clean by the free use of antiseptic lotions and douches. Stimulants must as a rule be given freely.

Ague (*Marsh Fevers*).—Ague is a disease generated by local conditions of uncertain nature, to which the terms "malarial" and "miasmatic" have been applied. Marshy, badly drained districts, and virgin soils when first dug up, are especially malarial, both in tropical and temperate climates. The poison is not conveyed from man to man, is usually confined to the district where the conditions are favourable to it, and is never found to travel across a mile of water or through thick belts of trees. It is more vigorous by night than by day, and is most active after rains or inundations when the ground is drying up. Ague may be of the *intermittent* or *remittent*

type, the former being more common in temperate, the latter and more dangerous form in tropical, countries.

An attack of *intermittent* fever has three well-marked stages:—

1. The cold stage. In this the patient shivers violently, complains of feeling cold, and suffers from pains in the body and limbs and general malaise. The skin becomes blue and rough (goose skin), the pulse is small and rapid, there is much thirst, and, notwithstanding the cold feeling, the temperature rapidly rises up to 104° or 105°, or higher. The urine is scanty and pale. This stage may extend over an hour or two.

2. The hot stage. This follows the first. The patient feels hot, and presents all the phenomena of high fever. The pulse becomes fuller, but is still rapid; the skin is flushed, and headache is intense. The temperature may be a degree or so less than in the first stage. The urine is scanty, but deeper in colour. The hot stage lasts from one to two hours.

3. The sweating stage. The patient now becomes more comfortable, the skin gradually becomes soft, moist, and then covered with sweat; the temperature falls, and the urine passed deposits lithates. Restorative sleep usually follows, and the patient awakes quite well.

The attacks come on periodically.

In quotidian ague the paroxysms are of daily occurrence; in tertian ague one day is missed; in quartan ague two days are missed. Double quotidian ague and mixed types are not uncommon. Of these the quotidian is the least obstinate; the quartan the least amenable to treatment. Turgescence of the spleen and liver always occur during paroxysms, and the spleen generally becomes much enlarged in chronic cases, giving rise to the so-called "ague-cake."

Remittent fever is much severer in its attacks, and more fatal in its results. The cold stage is often hardly noticeable; the fever in the hot stage is more lasting and exhausting; the paroxysms occur once or twice daily, and increase in intensity for some days, and there is no intermission of the febrile state between the attacks.

Treatment.—Persons who are exposed to malarial influences should wear flannel, avoid the night air, and take quinine regularly. Those who are attacked with the disease are best treated with quinine, given frequently, in four- or five-grain doses, or given just before the attacks in twenty- or thirty-grain doses. Liquor arsenicalis, in full

doses, is a very valuable remedy, often proving efficacious when quinine has failed.

During the cold stage hot sponging and warm applications are soothing, and warm drinks may be given. In the hot and sweating stages cold sponging is grateful to the patient. The patient, if possible, should be removed from the malarial district.

Results of Ague.—Ague is very likely to return and to tinge any other disease which the patient may subsequently acquire. Neuralgia, especially of the part of the fifth nerve supplying the forehead, is a troublesome condition. Sometimes the liver enlargement leads to ascites, or to attacks of jaundice. Anæmia is another frequent result of ague.

RHEUMATISM.

Rheumatic Fever.—Acute Rheumatism.—Acute rheumatism is believed to be due to the presence in the blood of lactic acid in excess.

Causes.—These may be divided into two classes—the predisposing and exciting. Among the predisposing causes hereditary predisposition is the strongest. Previous attacks, chorea, recent scarlet fever, continued exposure to cold and damp, injuries to joints, depressing conditions of life and anxiety of mind, are all favourable to an attack. The main exciting cause is exposure to cold or wet while in a state of fatigue or exhaustion.

Symptoms.—An attack of acute rheumatism may come on gradually, the severe symptoms of the disease being preceded for some time by pains in the limbs and feelings of malaise and depression; or the disease may be ushered in by rigors, which are soon followed by the characteristic pain and swelling in the larger joints. Several joints are usually affected in succession. Thus, for instance, the wrist joints may first become tender, red, and swollen; their temperature is increased, and the patient is unable to move the hands on account of pain. Subsequently the elbows or other joints get inflamed, until the patient may lie in bed quite unable to move himself. The temperature is usually high, and it is in this disease that we most commonly meet with cases of hyperpyrexia; it may range from 100° to 104°, or run up to 108° or more. As the disease runs no regular course, the temperature may fall in a day or two, or may keep high for a much longer period. The pulse is full and bounding.

The skin exhales a peculiar sour odour from the presence of an abundant acid perspiration. The urine is high-coloured, and deposits a copious sediment of urates. The tongue is white and the bowels are usually constipated. Acute rheumatism, without specific treatment, may run a very short course, and leave the patient weak, but quite free from pain, or it may assume a subacute form, which is extremely lingering and troublesome.

Complications and Sequelæ.—The most important fact in connection with acute rheumatism is the extreme liability of the endocardium, the valves of the heart, and the pericardium to be affected. The heart may indeed be primarily attacked without any, or with very slight, articular mischief. The pleuræ, the lungs, the membranes of the brain and spinal cord may each be affected. As a sequel to the heart lesions, emboli may give rise to blocking of vessels and hemiplegia or gangrene, according to the parts affected. Chorea may either precede, accompany, or succeed acute rheumatism.

The endocardium may be alone attacked with an ulcerative inflammation, or this condition may be consecutive to rheumatism. Ulcerative endocarditis gives rise, probably by separation of necrosed particles, to a septicæmic condition resembling often typhoid fever.

Treatment.—The patient must be kept completely at rest. Blankets and flannel should be used next to the skin in preference to linen, and pressure should be taken off the inflamed joints as much as possible. The skin, bowels, and kidneys should be kept fairly active. Pain in the joints may be relieved by soothing hot applications, and flying blisters are often found to be very serviceable. Opium or morphia injections are required if the pain is very great. Salicylate of soda, given in fifteen-grain doses every three or four hours, has undoubtedly proved the most serviceable drug yet used for acute rheumatism. It generally lowers the temperature and lessens the pain and inflammation of the joints. In many cases, however, it fails altogether to exert any influence on the symptoms. Salicylic acid or salicin may also be used. Alkalies, the bicarbonate of potash, the citrate, tartrate, &c., may also be given. The heart should be carefully examined frequently for any signs of inflammation, and, if this occurs, warm applications or blisters over the præcordium may be applied. The diet should be limited to beef-tea and milk; alcohol is only required if there is much pros-

tration. The thirst accompanying the fever may be treated with the usual cooling drinks. Great care is needed during convalescence, as the disease is particularly liable to recur.

Chronic Rheumatoid Arthritis — Rheumatic Gout —Nodular Rheumatism—Arthritis Deformans.—By all these names an affection of the joints, much more commonly met with in women than in men, is known. Whether or not it has any relation to gout is a disputed point, but it seems certainly to be related to rheumatism. It is usually a chronic malady, but may be subacute. It tends to attack chiefly the ill fed and poor. The joints affected, which may be almost all the joints of the body, or only a few, are at first swollen. This swelling is due partly to changes in the ends of bones, partly to changes in the synovial tissues and fibrous capsules, and often to semi-fluid accumulation outside the joint. As the disease advances the cartilages become eroded, and the ends of the bones become smooth or eburnated. The natural movements of the joints become interfered with, and crackling sounds are heard when the limbs are moved. This condition may go on to entire loss of use of the joints affected. Absorption of the neck of the thigh-bone is not uncommon in elderly subjects, so that the femur joins the pelvis at a very acute angle, and fractures occur readily in this situation under these circumstances. The general health sooner or later suffers.

Treatment.—There is no specific for this affection and no cure for it. The progress of the disease is sometimes arrested by tonics, baths, and hot local applications, and anything which improves the general health. Trousseau speaks highly of the internal administration of tincture of iodine, commencing with ten-minim doses. The application of hot sand, as hot as can be borne, is useful as a local application.

Chronic Rheumatism.—In chronic rheumatism the muscles or tendons in various parts of the body may be affected, or the joints may be attacked, giving rise to chronic articular rheumatism. Torticollis or wryneck, lumbago or rheumatism of the erectores spinæ, &c., and pleurodynia, are all forms of this affection. Where the joints are affected there is often much pain and stiffness with thickening about the articulations.

Treatment.—This should be local and constitutional. Strapping or plasters may be applied to give support to

the affected parts. Subcutaneous injections of morphia or acupuncture often relieves pain, and the application of large hot poultices, followed by warm dry applications, such as cotton-wool bound on by strips of flannel, is very serviceable. Internally iodide of potassium, guaiacum, and tonics may be given.

GOUT (*Podagra*).

Gout is a specific disease, in which nitrate of soda is deposited in the joints and in other situations; that substance is also found in excess in the blood during acute attacks.

Causes.—Heredity is very strongly marked. Men of middle life are more frequently attacked than women or the young. Workers among lead are especially prone to it, and people of a gouty predisposition are consequently easily poisoned by contact with lead. Free indulgence in animal food, and in certain alcoholic drinks, notably port wine, may induce the disease, and it is especially a disease of the rich, indolent, and intemperate. When gout has once established itself very slight accidents may excite an acute attack; such as over-eating or over-drinking, mental anxiety, or local injuries to a joint.

Symptoms.—An attack of acute gout is usually preceded for some days by digestive disturbances and irritability of temper. The advent of the disease most commonly takes place in the early morning, and one of the smaller joints, most commonly the metatarso-phalangeal articulation of the great toe, is the seat of an acute and intensely painful inflammation. The superficial veins of the foot become enlarged and prominent, the skin over the toe becomes of a red hue likened to the peony, and glossy like the surface of a tomato, and there is swelling and redness extending some distance up the foot. The pain now becomes unbearable, and has been likened to thrusts with red-hot knives, to squeezing in a vice, to a dog gnawing the bone, &c. Towards morning the pain ceases, and there is relief until the next night. Usually an attack of gout lasts for four or five nights, when the swelling becomes less tense, slight desquamation sets in with a good deal of itching, and the series of paroxysms is over for a time. The urine towards the end of an attack deposits abundant urates, and there is often a critical perspiration. The first attack of gout usually takes place about the end of January or beginning of February,

and there is always a tendency of the disease to recur in the early spring or late autumn.

Other Manifestations of Gout.—Chronic gout is a condition in which deposits of urate of soda occur in various joints to such an extent as to cause deformity, often considerable. Similar deposits, tophi or chalk-stones, often are found in the helix of the ear, in the eye-lids, and elsewhere. In such cases the patient is liable to paroxysmal attacks of acute or subacute gout. There is usually much weakness, and the patient suffers from mal-nutrition. The kidneys suffer chronic change, becoming granular and contracted. The skin is liable to be affected with an intractable eczema or other form ot chronic eruption. Bronchitis and asthma are frequent. When a gouty diathesis is once established, no viscus is safe from its insinuating effects. Chronic hepatitis, making the liver hard and granular, as in cirrhosis, sometimes occurs. The name *retrocedent gout* is given to dangerous disturbances of the stomach, heart, or nervous system which are frequently seen in gouty persons. In fact, it is well to bear in mind the expression of Sydenham with regard to acute gout, "totum corpus est podagra," and to expect to find no part of the body which may not be primarily or secondarily attacked by the poison.

Treatment.—The most important part of the treatment of acute gout consists in carefully dieting the patient during the intervals of the attack. A vegetarian diet agrees remarkably well with many gouty persons, and the use of alcohol should be, if not absolutely forbidden, at least greatly restricted. Water may be drunk freely, and when possible regular exercise should be taken. Sydenham, who suffered much with gout, urges very strongly that no medicines should be used at all, and that even the pain should not be relieved, as it is itself a medicine which tends to cure the disease. Trousseau agrees with this doctrine, and says that in his experience he has more than once regretted interfering, but has never regretted holding his hand in acute gout. The danger of using remedies to cut short the attack is that the disease may easily thus be converted into regular chronic gout, bringing in its train all the evils of mal-nutrition already mentioned. Bearing in mind this danger, which is no doubt exaggerated by the fact that patients are apt to trust to the efficacy of medicines and

to neglect hygienic rules, we find that in colchicum we have a drug of great service more especially in acute gout. From ten to twenty minims of vinum colchici, combined with some alkaline carbonate, may be given three or four times a day. The bowels should be freely opened, and the skin encouraged to act by vapour baths or other means. Opium or morphia injections may be used to allay the pain of the paroxysms. Drinking freely of very hot water during the acute stage has also been recommended. It is important, of course, to keep the inflamed joint at rest, and protected by being swathed in flannel bandages over cotton-wool. In broken-down individuals tonics, quinine, cinchona, iron and vegetable bitters, with a light nutritious diet, is called for. Iodide of potassium, lithia water, and the natural waters of Buxton, Bath, and many of the German springs, have a high reputation ; but these waters should never be taken in large quantities, or for more than ten or twelve days at a time. If visceral gout, through bad treatment and accidental causes, comes on, our endeavour ought to be to produce an attack of articular gout by blistering or otherwise irritating one of the smaller joints.

Scurvy (Scorbutus).—This is a disease usually confined to seamen who are deprived of fresh vegetables for a long period, but may appear under similar circumstances among dwellers on land. Insufficient food, exposure to privations, and (as in Arctic expeditions) deprivation of sunlight and extreme cold aid in its production. The chief symptoms are gradually increasing weakness and mental depression; the mouth becomes sore from sponginess of the gums; the teeth become loose and fall out; hæmorrhages occur from mucous surfaces and into the subcutaneous tissue. Old ulcers or wounds break out afresh, and it is said old fractures may become disunited. The breath is offensive, the bowels confined, and the urine scanty and sometimes contains blood.

Treatment.— Scurvy yields rapidly and easily when fresh vegetables are added to the diet. Lemon-juice or lime-juice are the most valuable preventives. Locally, Condy's fluid in solution is useful as a wash for the mouth, and at first only soft or liquid diet should be given to the patient.

Purpura.—Purpura arises from bad hygienic conditions, or may come on in the course of chronic wasting

diseases. It is found in two forms—purpura simplex and purpura hæmorrhagica. In the first case we find numerous capillary extravasations under the skin, with some general malaise. It is not usually dangerous to life. In the second form there are larger subcutaneous hæmorrhages, bleeding from the mucous surfaces, and intense prostration. The whole surface of the skin may be mottled with purpuric spots, and sometimes blisters form, which become filled with blood-stained serum. The pulse is quick and feeble, there may be considerable febrile paroxysms, and the danger to life is great.

Treatment.—The diet should be generous, but light and easily digested. The bowels should be regulated, the patient kept at rest, and the body should be kept clean by frequent sponging. Ergot has been recommended to check the hæmorrhages, and turpentine, acetate of lead, and other astringents may be used for the same purpose. Iron and other tonics should also be given.

DISEASES OF THE RESPIRATORY APPARATUS.

Pleurisy.—Pleurisy, or inflammation of the serous sac covering the lungs and chest walls, may be due to local injury or extension of inflammation from some adjacent part, to exposure to cold and wet, or it may occur in the course of an acute specific disease, such as scarlet fever. In phthisis some degree of pleurisy is almost invariably found.

Pleurisy may be acute or chronic, with or without much effusion of serous fluid. There is at first hyperæmia of the affected part, then, following this, effusion into the serous sac of an albuminous fluid containing fibrin and white corpuscles—the so-called plastic lymph. A coagulation of the exuded products takes place, forming a "false membrane" between the adjacent serous surfaces, and on the absorption of the fluid portion this false membrane becomes vascular, and by uniting the thoracic and pulmonary layer of the pleura obliterates the pleural cavity. In other cases the effusion becomes purulent, forming an empyema.

Symptoms.—The symptoms of inflammation of the pleura of small extent are—pain of a sharp stabbing character in the affected part, tenderness, and short, shallow respirations. On auscultation a friction sound may be heard with the breathing, and there may be some

dulness on percussion. If much fluid is exuded the pain diminishes, and the friction sound ceases. There may be considerable or only slight constitutional disturbance, the pulse is somewhat faster than normal, and the temperature may be raised two or three degrees. When much fluid is present in the pleura there is always dyspnœa. The affected side moves little or not at all in breathing, and on measurement is found to be larger than the sound side. Sometimes fluctuations can be felt between the ribs when there is much bulging. The heart may be displaced to the right side of the thorax in left pleural effusion, or covered over with distended lung if the mischief is on the right side. There is dulness on percussion, with complete loss of vocal fremitus, and the air-sounds are distant or absent. A peculiar bleating sound may sometimes be heard on applying the stethoscope over the lower angle of the scapula when the patient speaks. This is supposed to be due to the passage of the sound through a thin layer of fluid which filters the tones of the voice, only allowing the high notes to pass through. On the sound side, and in the unaffected part of the lung, the breath sounds are exaggerated. As the effusion subsides friction sounds reappear. Sometimes absorption does not go on satisfactorily, and the effusion becomes chronic or else becomes purulent. When death occurs, it usually takes place in cases where there are large effusions, and is due to syncope. In such cases the mere act of getting out of bed may be sufficient to cause death.

Treatment.—Removal of the exciting cause is the first requisite. In cases where the pleurisy is due to cold, the patient should be kept in bed, and hot linseed poultices, or linseed with mustard, should be applied over the affected side. If the amount of effusion is so great as to interfere seriously with breathing, or if the fluid is slow in disappearing, the aspirateur may be used to remove it, and especial care should be taken that the patient does not attempt any excessive physical exertion. Aconite or tartar emetic may be given internally in the pleurisy of strong, robust persons. Cod-liver oil and iodide of potassium are useful in chronic pleurisy.

Empyema (Suppurative Pleurisy).—In scarlet fever, typhoid fever, the puerperal state and pyæmia, inflammation of the pleura, when it occurs is liable to result in an accumulation of pus in the pleural sac. Empyema may also occur from the extension of inflammation to neigh-

bouring parts; an abscess may open into the thorax from the abdomen or axilla, or, as frequently happens in phthisis, the walls of a cavity may break down and give rise to pneumothorax with empyema.

According to Dr. Powell, the symptoms of suppurative pleurisy do not in many cases differ very strikingly from those of serous effusion; they are less acute but more adynamic; the rigors are more frequent and persistent, the pulse is more frequent, and the tongue has a tendency to become dry and brown; there is more anxiety of countenance, and the patient has frequent hectic sweats. Œdema of the chest walls, an erysipelatous flush over the chest wall or evident pointing, are certain signs of the presence of pus. The heart, as in serous effusion, is pushed towards the sound side.

Treatment.—Where there is no doubt about the presence of pus the thorax should at once be emptied. This may be done by the aspirateur or by the trocar and canula, or by the knife. Care should be taken to keep the cavity clean, and for this purpose antiseptic solutions should be used frequently if the cavity is opened. Tonics should be given, and change of air is useful as soon as the patient commences to recover strength.

Pneumothorax.—Air may get into the pleura from rupture of the lungs through accident, or from breaking down of a cavity in phthisis. It is often associated with hæmothorax or blood in the pleural cavity, or with empyæma or ordinary pleuritic effusion. The special symptoms of pneumothorax are sudden pain and excessive dyspnœa, on percussion there is usually hyper-resonance over the affected side, but sometimes if the accumulation of air is great there is dulness. On auscultation the breath sounds are absent or distant, and air can sometimes be heard passing in and out of the pleura if the tract of pneumothorax be small and separated from the rest of the pleura by adhesions. If there is fluid as well as air in the cavity, this can often be diagnosed by shaking the patient, when a splashing sound may be heard, often audible to the patient or bystanders.

Treatment.—Sometimes aspiration may be necessary to remove the air. Usually the only treatment required is that of the condition which has brought about the pneumothorax.

Thoracic Tumours.—Tumours of various kinds are often found in the thorax in connection with or uncon-

nected with the lungs. The most common are:—1. Aneurism. 2. Malignant growths in connection with the œsophagus, mediastinal glands, lungs, &c. 3. Simple lymphoid growths. 4. Abscesses from caries of the spine, or other causes. 5. Bony growths from the spine. 6. Hydatid tumours. The symptoms of these new growths vary according to their size and situation. Suffocation or dyspnœa may be produced; one lung or part of a lung may be obstructed, the heart may be pressed upon, swallowing may be interfered with or prevented, &c. The treatment will depend on the nature of the obstruction diagnosed, but in most cases little can be done.

Bronchitis.—Inflammation of the bronchi most commonly arises from exposure to cold and wet, but is also often associated with measles, hooping-cough, and other specific fevers. It may be acute or chronic in its character.

Acute bronchitis may attack only the larger tubes, or the inflammation may descend into the smaller ones, giving rise to capillary bronchitis. In both cases the disease is a severe one, in the latter it is dangerous to life, especially in young children. Acute bronchitis generally commences with inflammation of the trachea and larger tubes. The patient complains of pain over the sternum, a feeling of rawness and irritability of the throat, especially on breathing cold air, and cough. At first there is little or no expectoration, but soon there is a secretion of mucus, at first tenacious, becoming white and frothy, and at last muco-purulent in character. As the inflammation advances febrile symptoms are manifested, and dyspnœa may become very marked. There is no alteration in the percussion note; auscultation in the dry stage reveals abnormal sounds; in the dry stage there are musical rhonchi; in the moist stage the sounds are sibilant or hissing, and crepitation is heard. In capillary bronchitis all the symptoms are exaggerated. The temperature may rise four or five degrees, alarming dyspnœa is present, and there is often great difficulty in getting rid of the mucous secretion.

In chronic bronchitis the secretion may be scanty or excessive, thin or tenacious. The terms dry bronchitis, bronchorrhœa, and plastic bronchitis, have been applied to different conditions where the discharge is scanty, excessive and watery, or so firm as to form casts of the bronchial tubes. The symptoms of chronic bronchitis are

cough, with or without expectoration, often slight streaky hæmoptysis, and râles which may be musical or sibilant are heard on auscultation. Bronchitis may end in complete resolution, leaving no ill effects beyond attending to succeeding attacks. Often, however, the chronic condition leads to emphysema, dilatation of the bronchi, and to asthmatic attacks. The acute form may end in collapse of portion of the lung, in phthisis from catarrhal pneumonia, or in ulceration and grangrene.

Treatment.—In acute bronchitis the patient should be kept in bed in a room of a temperature of about 65° with the air, if necessary, kept moist by steam. Poultices or other warm applications should be applied to the chest. Putting the feet in hot water, or the use of a vapour bath, often gives much relief. If the secretion is excessive and expectoration difficult, emetics may be given; this is especially needful often with children. Expectorants, such as ipecacuanha, squills, &c., combined with nitrous ether and ammonia, are useful. In the later stages, and in chronic bronchitis, senega may be given with carbonate of ammonia. During convalescence, cod-liver oil, iron and other tonics are often of much service. Change of air is nearly always useful, and where it is possible a sea voyage or wintering abroad may make an otherwise incapacitated person useful and comfortable.

Those subject to bronchitis will be more likely to escape attacks if they take exercise regularly in the open air, use the cold or tepid bath; rise early and observe strict temperance in everything, rather than by too much wrapping up and nursing themselves.

Bronchiectasis. — Bronchiectasis, or dilatation of bronchial tubes, generally occurs in connection with chronic bronchitis or phthisis. The tubes may be regularly dilated, or the dilatation may be globular in shape or irregular and connected with several bronchi. The symptoms resemble those of the disease which has set up the conditions. In phthisis it is often difficult to tell a dilated tube from a cavity. In bronchitis with bronchiectasis the breathing is short and difficult, the expectoration is profuse, and often exceedingly fœtid. The treatment required is, in the main, that of the primary disease. Inhalations of turpentine or camphor are often useful in checking fœtor and excessive secretion.

Emphysema.—Interlobular emphysema (not surgical) is found only in young children. It is characterized

by the escape of air into the interlobular connective tissue, and is usually due to hooping-cough or bronchitis.

Vesicular emphysema is due to an expansion of the air vesicles with loss of elasticity of the lung substance. It is generally associated with chronic bronchitis, or is found in persons who play wind instruments or in other ways violently exert the lungs, or in persons who have lost the use of part of one or both lungs from collapse, phthisis, &c.; a vicarious emphysema is often set up in the sound parts. The lung is enlarged in emphysema and does not collapse on opening the chest wall; in senile emphysema, however, the lung may be much diminished in size: here the emphysema is due to absorption of the walls of air vesicles and the consequent running together of adjoining alveoli. Three causes have been assigned for emphysema. These are, violent inspirations over-distending the air vesicles, violent expirations with partial closure of the glottis, thereby directing the force of the expiration back upon the air vesicles, and degenerative changes occurring in the walls of the alveoli and permitting passive dilatation. Probably all three conditions take part in the production of emphysema. The *symptoms* of emphysema are shortness of breath, tendency to bronchitis and asthmatic attacks, and congestion of the abdominal viscera as in mitral disease. Externally the configuration of the chest is altered; it becomes enlarged in all its diameters—the back of the chest becomes curved, and the angles of the ribs increased. The movements of the ribs become shallower and more frequent. The percussion note is more resonant than normal, and the respiratory sounds more feeble.

Treatment.—This must be directed to the diseases which have brought about emphysema, and to the complications which arise. The patient should wear warm clothing, avoid exposure to cold and damp, and live quietly and temperately.

PNEUMONIA.—ACUTE CROUPOUS OR LOBAR PNEUMONIA is usually the result of exposure to cold and wet. It may likewise arise from injury to the lungs, and a septic form is very common in connection with erysipelas, pyæmia, typhoid fever, and other acute diseases. Pneumonia can hardly be looked upon in any case as a mere local disease. It is more likely due to a general constitutional affection of which the inflammation of the lung is a local manifestation. Lobar pneumonia presents three well-marked anatomical conditions. The *first* stage is

marked by engorgement of the affected lobe; there is determination of blood to the part, the lung becomes dark red in colour, heavy, friable, and less elastic than normal. In the *second* stage it becomes solid from exudation of liquor sanguinis, and blood corpuscles into the air cells and pulmonary tissue. The epithelium of the alveolar walls becomes swollen and granular. This is the stage of red hepatization. The *third* stage is marked by increased exudation of white cells from the blood, by proliferation of the alveolar epithelium cells, and by rapid fatty degeneration of the contents of the air vesicles. The whole affected lung becomes grey in colour, soft and friable, and of increased specific gravity. This is the stage of grey hepatization. In the second and third stages there is no air in the diseased parts, and they sink on being cast into water. The usual course of the disease is now towards absorption of the exuded matters, and a return of the lung to its healthy condition. In debilitated subjects, drunkards and others, resolution may not take place, but gangrene, abscesses, or chronic pneumonia may result. In all cases of pneumonia examined post mortem the different stages can be observed in the same lung. The symptoms of pneumonia are usually well-marked. The disease commences with sudden rigors, rise of temperature, and feelings of general malaise. Within a few hours pain in the affected part, dyspnœa, and cough direct attention to the lung. On auscultation fine crepitations can be heard in the first stage. There may be some dulness, and vocal fremitus is increased. In the second and third stages the dulness on percussion is absolute. Breath sounds are tubular, and later on moist bubbling sounds are heard, or fine crepitations as in the first stage. The expectoration is at first scanty and tenacious, and soon becomes rust-coloured from the presence of blood. As the disease advances expectoration becomes more copious, loses its rusty colour, and finally has the character of ordinary bronchitic sputum. The constitutional symptoms are usually severe. The temperature may run up to 106° or higher, the pulse is quickened, dyspnœa is well-marked, and in severe cases the disease is apt to take on typhoid characters; the tongue becomes brown and hard, and delirium, stupor, or coma come on. The urine is scanty and high-coloured, and is remarkable for its deficiency or lack of chlorides; a herpetic eruption about the lips is very common. Pneumonia most com-

monly attacks the basal lobe of the right lung, but may affect any part. It generally runs its course in from seven to ten days, and the fever usually ceases by crisis—that is, the temperature falls quickly or almost suddenly, resolution proceeds rapidly, and except for great weakness the patient is well. Sometimes defervescence is more gradual.

Treatment.—The patient should be kept at rest in bed in a warm room, and supplied with light nutritious diet, and stimulants if there is any tendency to prostration. Hot applications, poultices of linseed or mustard and linseed may be applied to the chest; some practitioners, however, prefer to use cold applications. In plethoric persons bleeding relieves the dyspnœa, but is not much employed on account of its disadvantages in the later stages of the disease; the same remark applies to the internal use of tartar emetic and other depressants. To reduce the temperature in pyrexial and hyperpyrexial cases quinine or salicylate of soda in full doses may be given, and cold, wet, or ice packing has also been tried with advantage. During convalescence great care must be taken that the patient is not exposed to chills or fatigued. Tonics should be given along with good diet; removal to good pure air, and to a warm climate when that is possible, is desirable.

Catarrhal Pneumonia—Lobular Pneumonia—Broncho-pneumonia.—These names are given to a form of inflammation which attacks small portions of lung tissue at a time. Unlike croupous or lobar pneumonia, which in so many cases is of constitutional origin, lobular pneumonia seems in most cases to be the result of direct local irritation. It is commonest among children who have been suffering from acute bronchitis, but is very frequent among adults under the same circumstances, or after chronic bronchitis among those who habitually breathe air loaded with irritant materials—air especially which has been rendered foul by animal exhalations. The bronchial secretions and other foreign particles, getting directly into the alveoli, set up irritation; in consequence the air vesicles get filled with secretions, mainly consisting of epithelial cells derived from those normally lining the alveoli, but containing also white corpuscles and a gelatinous looking substance. Catarrhal pneumonia may also be secondary to pulmonary collapse, occurring from stopping up of small bronchi by plugs of mucus. The affected areas become congested, the

exuded material undergoes degenerative changes, the walls of the alveoli are apt to give way, and thus the mischief creeps from lobule to lobule, giving rise to a very common form of phthisis. Under favourable circumstances resolution may occur, or the products of the inflamed area may become calcareous and encapsuled, and give no further trouble. Far more commonly the destructive process goes on with more or less acuteness.

The symptoms of this disease are often at first marked by those of bronchitis. There is constant cough and expectoration, *with chronic pyrexia*, the temperature being in the evening usually, often all day long, a degree or a few degrees above normal. The patient loses flesh and sweats, and upon examination of the chest bronchial râles and crackling sounds may be heard. Percussion does not as a rule yield any information early in the disease, owing to lobular pneumonia attacking only small isolated portions at a time; later on dulness and the other physical signs of phthisis become well-marked.

Treatment.—The importance of sufficient cubic space in sleeping and living rooms cannot be over-estimated in this and other forms of lung disease; without pure air any form of treatment must be abortive. If the patient is confined to his room care must be taken to keep the air warm and to avoid draughts. Cod-liver oil is most useful in the early stages, but may be given throughout with tonics and with light nutritious diet. Expectorants may be given to relieve cough; counter-irritation, used cautiously, is often useful.

Pulmonary Phthisis—Consumption.—Any acute, subacute, or chronic inflammation of the lungs which does not tend to resolution (as croupous pneumonia does) and which is accompanied by general wasting of the body, may be properly called pulmonary phthisis. It is one of the commonest and most fatal diseases of temperate climates.

Causes.—In the majority of cases there is an inherited tendency to pulmonary weakness. Persons of the strumous diathesis are especially liable to be attacked. Repeated attacks of bronchial catarrh, acute bronchitis, and pneumonia are often followed by phthisis. By far the most important factor in its production, however, is impure air, especially air rendered impure by breathing. To cite only a few instances very briefly, it may be mentioned that phthisis is common among the native

population of the West Indies and New Zealand,* who sleep huddled together in close rooms, while it is hardly known, unless imported, among the white population who sleep and live in large airy rooms; phthisis in the army and navy has steadily declined as the sleeping accommodation in barracks, &c., has been improved, other conditions remaining the same; exactly the same conclusions must be drawn from the statistics as to horses and other animals, which suffer much from phthisis only when kept in close stables;† again, various occupations in which the workmen must breathe air full of irritating particles have given their names to special varieties of phthisis: thus we have knife-grinders', colliers', miners' phthisis, &c. Overwork, mental anxiety, and any condition which depresses the general health, may act as potent predisposing causes. A cold, damp climate most probably acts indirectly, by causing overcrowding and neglect of ventilation, and directly, by setting up chronic or acute bronchial catarrh.

Symptoms.—The beginnings of phthisis are often obscure. The patient loses his appetite, or is capricious or fantastical in his eating and drinking. There is often a marked objection to all fatty food. He is languid and wanting in energy. The circulation is feeble, and he is troubled much with cold in the extremities; he cannot keep warm. In women menstruation becomes irregular or ceases. Cough may be slight or troublesome, with or without expectoration; or the first appearance of illness may be marked by more or less copious hæmoptysis. *The temperature is raised and the pulse quickened.* These symptoms should be carefully and regularly looked for in all suspected cases. As the disease becomes declared there are usually copious night sweats, loss of flesh, increasing debility, shortness of breath, and pain in the chest. Later on the appearances become more marked; a hectic flush may be present, or the complexion may become dull and swarthy; the expectoration is usually profuse and purulent, and hæmoptysis is often a leading and frequent symptom. There is constant pyrexia, want of appetite and digestive power, frequently there is diarrhœa, and the wasting of the body becomes extreme. The mental phenomena of

* Dr Bakewell on the Hygiene of Bedrooms, vol. xxvii.: *The Practitioner*, p. 348.

† See Parkes on Hygiene, for many instances of this kind.

the patient are remarkable for the extreme hopefulness with which he usually regards his condition. In the last stages of phthisis patients will often make plans for the next year and the year after. The physical signs vary much according to the stage and variety of phthisis. If there is a large tract of consolidation there will be dulness on percussion, but if the inflammation is disseminated the percussion note may be almost normal. Auscultation reveals crackling and crepitation in those parts of the lung which are attacked by inflammation; if there is much consolidation, tubular breathing will also be heard. The crackling is best heard at the end of inspiration, and the expiratory sound is harsh and prolonged. As consolidation advances, and breaking down of lung tissue comes on, cavities reveal themselves by hollow cavernous breathing, and by the sound of the patient's voice when he whispers being conveyed to the ear by the stethoscope. Inspection shows that the chest is emaciated; there are fibrillar twitchings of the muscles; there is frequently partial flattening from retractation of the lung, with bulging elsewhere from vicarious emphysema of the lung. If there is much consolidation palpation reveals increased vocal fremitus. The complications of phthisis are many and grave. Inflammation of the lungs has this analogy to inflammation of the kidneys—that in both an acute inflammation often attacks the working portion of the organ, supervening on a subacute or chronic inflammation, and quickly carries the patient off. Tuberculosis, general or local, may be set up, and the patient may die of tubercular meningitis, or the intestines may become the seat of an exhausting and fatal ulceration, or the mesenteric glands may become infected and the patient may die of inanition. In the progress of the ulceration of the lung, blood-vessels may be ruptured, and lead to severe or fatal hæmoptysis. Pleurisy is a constant accompaniment of phthisis, and empyema and pneumothorax are not uncommon. Some amount of bronchitis, often with dilatation of the tubes or ulceration, is always present. Ulceration of the larynx may lead to complete loss of voice. Œdema pedum often comes on in the last stage, and Bright's disease, fistula in ano, diabetes, are among the other complications which may arise. The course of the disease is variable, and depends much on surrounding

circumstances. Death may occur in a few weeks or months, or life may be prolonged for many years.

Varieties of Phthisis.—The chief forms of phthisis are pneumonic, tubercular, and fibroid.

Pneumonic Phthisis.—Catarrhal pneumonia, elsewhere described, is the chief type of this variety of phthisis. Many physicians consider it the commonest form of consumptive disease. Pulmonary capillary hæmorrhage may be the starting-point of pneumonic phthisis; the alveoli get blocked up; there is congestion of surrounding tissues, followed by degeneration and breaking down. This is sometimes spoken of as "*phthisis ab hœmoptoë*," or hæmorrhagic phthisis. The course of pneumonic phthisis may be acute, chronic, or intermitting.

Tubercular Phthisis.—Acute pulmonary tuberculosis may arise primarily in the lung, may come on in the course of other forms of phthisis, or as a part of general tuberculosis. It is part of a general infective process, which may arise from some primary local lesion, which lesion is frequently a caseous patch in the lung, the result of catarrhal pneumonia. It is characterized by the presence of tubercles, grey and yellow, scattered throughout the lung. The grey are small, firm, and semi-transparent; the yellow are larger, softer, and caseous. The grey are believed to degenerate into yellow, and the yellow are believed to break down and become the sources of fresh infection, by being absorbed by the lymphatics. Aggregations of yellow tubercules will originate cavities.

Fibroid Phthisis.—In this form, great increase in the fibrous stroma of the lung is the predominant character. Cicatrization follows, and the course of the disease is slow. Aneurismal dilatations are not infrequent, and from rupture of these or erosion of vessels there is often a great amount of hæmorrhage. In most cases of phthisis there is a mixture of types, sometimes one predominating, sometimes another.

Phthisis as an Infectious Disease—Dr. Koch, of Berlin, who has done so much to make clear the life-history of the bacillus, which is found in the blood in splenic fever, has lately published the results of a long and careful investigation into the causes of tubercular phthisis. He has found and demonstrated by appropriate histological methods a bacillus in phthisical sputum and phthisical lungs, which he has been able to rear in solutions outside the body. These bacilli so reared are kept

growing for many months. He has introduced them into various animals, taking every precaution that no other infectious matter should be introduced at the same time, and the result has been that in susceptible animals true tubercular disease of the lungs and other organs has been induced. It is difficult to resist the conclusion that these bacilli are, at least in many cases, the active agents in bringing about the phthisical condition. It is, of course, obvious that the lungs must be in a condition favourable to the life of these organisms before they can become dangerous, or that very large doses of the infecting material must find entry into the system.

Treatment.—Persons of a phthisical tendency should lead an open-air life, live temperately, and avoid over-fatigue. In the early stages of the disease, change of climate or a sea-voyage has often the best effect. The general indications of treatment are to supply the lungs with pure, dry air, to give them as much rest as possible, and to support in every way the bodily strength. Cod-liver oil is decidedly the most useful of all drugs. The various symptoms must be treated as they arise. No disease calls for more careful attention; but for details of treatment we must refer to some of the special works on consumption, such as Dr. Powell's and others. Counter-irritation by means of iodine liniment is often useful. Arsenic frequently reduces temperature and checks consolidation. Belladonna, quinine, sulphuric acid, oxide of zinc, and other drugs, are useful in checking night sweats. Chloral or chloroform, and antiseptic inhalations, may be used to check cough and lessen purulent expectoration. Opium, as a rule, is a dangerous drug to rely upon. Digitalis, ergot, gallic acid, and other drugs, are useful in hæmoptysis. The use of the hypophosphites has been much lauded in the early stages of phthisis in young subjects.

ASTHMA.—True spasmodic asthma is a disease commoner in men than women, usually coming on early in life, and then being of life-long duration. It seems to depend on spasmodic contraction of the muscular tissue of the bronchial tubes, and has been compared in this respect with the epileptiform convulsions which, in many cases of central nervous disease, affect groups of muscles elsewhere.

Attacks of asthma usually come on in the early morning. The patient is roused up from sleep by a feeling of suffocation; there is intense dyspnœa and desire for fresh air; the ordinary and extraordinary muscles of inspiration act

to their fullest extent; but breathing is jerking, shallow, and inefficient. Respiration is noisy, and on listening with the stethoscope loud sibilant rhonchi are heard all over the chest. Signs of deficient aëration of the blood are prominent, and the pulse is small and quick. The duration of a paroxysm is variable, and it may subside suddenly or gradually. Attacks are likely to occur after heavy or indigestible meals, on exposure to changes of temperature, from any irritation of the respiratory organs, or from reflex irritation of any kind. Periodicity is often very marked. Previous to the attack the patient often passes large quantities of pale urine; there may also be cough and dyspnœa, and general nervous irritability.

The causes of asthma are obscure. It is often hereditary, or associated with a family neurotic history. It generally produces emphysema and a tendency to attacks of bronchitis. Asthmatic attacks are often associated with gout, bronchitis, emphysema, and cardiac mischief, but these are usually easily diagnosed from the true spasmodic form.

Treatment.—During an attack, everything which impedes respiration should be removed. Strong tea or coffee often helps to cut short a paroxysm. Slight chloroform inhalations are useful, but temporary in their effects. Inhalations of nitre, stramonium, tobacco, lobelia, and other sedatives, prove useful, but all remedies are likely to lose their effect in time. Chloral and large doses of belladonna, given internally, will often give relief. The habits of life of asthmatic persons must be carefully regulated, but no hard-and-fast lines can be laid down, as hardly two cases are exactly alike; some do best in cities, some in the country. The diet should be light, and all late meals should be avoided. The treatment at Mont Dore has been very highly spoken of; it is a combination of mountain air, inhalations of vapour containing arsenic, vapour baths, and careful hygiene.

Hay Asthma (Hay Fever).—This is an affection to which certain individuals are highly susceptible. It comes on, as a rule, in the early summer, and in the country, and is supposed to be due to the irritation caused by the inhalation of pollen grains. The symptoms consist of catarrh of the eyes and nasal mucous membrane, with irritation of the throat, cough, and dyspnœa, which last as long as the patient is exposed to

irritation. Some people suffer in the same way from ipecacuanha, linseed meal, or other fine powders. The treatment consists in keeping out of the way of irritants. Injecting the nostrils with quinine solutions has been found beneficial; and nasal plugs have been invented to filter the air before breathing it.

Laryngitis.—Laryngitis may be either acute or chronic. The causes are exposure to cold and wet, injuries, over-exertion of the voice, syphilis, phthisis, or some acute specific fever.

In acute laryngitis there is loss of voice, pain and dyspnœa. If the inflammation is extensive, symptoms of suffocation may come on. In the chronic form there may be little pain and no dyspnœa, but the patient loses his voice more or less completely. Clergyman's sore throat is a common form in syphilitic and tubercular ulcerations, loss of voice is also a prominent symptom. Laryngitis is generally followed by tracheitis and bronchitis, and usually accompanied by inflammation of the fauces. Its chief danger lies in the possibility of the glottis becoming completely obstructed, and so causing death by suffocation. The treatment of the acute form consists in keeping the patient in a warm room, and giving inhalations of steam with some sedatives added. Local application of astringents are often needed. Leeches or counter-irritation may be applied outside, and sometimes scarification of the vocal cords may be required. If dyspnœa is excessive and suffocation is threatened, tracheotomy may be needed. In the chronic form avoidance of cold air and rest of the voice are needful. Tonics, cod-liver oil, &c., may be given internally. If the disease is syphilitic, iodide of potassium must be given.

Loss of voice, besides being caused by laryngitis, may also be due to other morbid conditions. The chief of these are :—

1. Polypi or other tumours within the larynx.
2. Tumours pressing on the larynx from without.
3. Aneurisms or other tumours pressing on the recurrent laryngeal nerves.
4. Paralysis of the vocal cords, from central or peripheral nervous lesions.
5. From hysteria.

The diagnosis of these conditions will generally be made by the examination of the throat by the laryngoscope,

and a careful consideration of the general history and physical condition of the patient.

Laryngismus Stridulus, Tetanus, Spasmodic Croup.—This disease occurs chiefly in children, and is marked by attacks of dyspnœa coming on usually at night, accompanied with noisy, crowing, inspiratory sounds. Air does not enter freely into the lungs, and during the paroxysms, which resemble those of true croup, suffocation is threatened or may actually occur. The attacks have a tendency to recur, and are often associated with spasmodic contractions of the feet, throat, and other parts.

During an attack cold water may be dashed on the chest and throat, or very hot sponging may be tried, of the same parts. Chloroform inhalation, artificial respiration, friction, and emetics are other methods of treatment. During the periods of intermission care should be taken of the general health, and any source of irritation must be treated.

Examination of the Chest.—Information as to the condition of the thoracic organs may be obtained by—

1. Inspection and measurement.
2. Palpation.
3. Percussion.
4. Auscultation.

Inspection shows—

1. Abnormalities in the shape or size of the chest, such as flattening, bulging, &c.
2. Excessive or inefficient movements, partial or general.
3. Tumours, pulsating or motionless.
4. Cardiac pulsation and position of the heart's apex.

Measurement shows the comparative bulk of the two sides of the chest, and taken after a deep inspiration and expiration the relative amounts of expansion.

Palpation reveals—

1. Excessive or diminished vocal fremitus.
2. Fluctuation.
3. The nature of tumours.
4. The position of the apex beat more exactly than inspection.

Percussion shows—

1. Resonance or hyper-resonance.
2. Dulness.
3. Tympanitic, amphoric, or crack-pot sounds.
4. Tenderness.

Auscultation reveals the nature of—
1. Breath sounds.
2. Voice sounds.
3. Cough sounds.
4. Heart or aneurismal murmurs.

The following Table, taken from Dr. Powell's work on Consumption, shows the meaning of the various sounds which may be heard on examining the chest :—

Percussion Note.

Clear	Normal over lung.
Dull	Normal over heart. Over lung indicates consolidation, fluid, or a tumour.
Wooden or hard . .	Lung induration, or thickened pleura.
Tympanitic, amphoric, or crack-pot sound	An empty rigid walled cavity (communicating with a bronchus) near the surface.
Hyper-resonance . .	Emphysema, or pneumothorax.

Breath Sounds.

Weak	Deficient function, as in emphysema.
Harsh	Partial consolidation, or undue dryness of tissue.
Exaggerated . . .	Puerile, normal in children; increase of function, as in consolidation elsewhere.
Suppressed . . .	Lung distant from surface, or obstructed bronchus.
Jerking	Partial consolidation; nervous.
Expiratory murmur prolonged . . .	Partial consolidation.
Bronchial	Partial consolidation.
Cavernous	A cavity.
Amphoric	A large cavity.

Bronchi.

Sonorous	Bronchitis in large tubes.
Sibilant	Bronchitis in small tubes; spasm as in asthma.
Crepitant, fine crepitation	Pneumonia.
Subcrepitant, large crepitation	Thin fluid in bronchi, consolidation around.

Dry crackling, clicking	Softening "tubercle," first stage; heard at end of inspiration.
Humid crackling .	Softening tubercle, second stage; heard during inspiration and expiration.
Mucous	Bronchitis with fluid secretion.
Cavernous gurgling	Fluid secretion in a cavity.

Vocal Resonance.

Bronchophony . .	Voice conducted through solid lung.
Pectoriloquy . . .	Voice intensified by a cavity.
Ægophony . . .	Voice conducted through a compressed lung and thin layer of fluid.
Amphoric resonance	Large echoing cavity with small opening; pneumothorax.

Cough Sounds.

Bronchial	Narrowed bronchus.
Cavernous	Cavity near surface containing some secretion.
Amphoric, large dry cavity	Pneumothorax.
Metallic tinkling . .	Sound of a drop of fluid echoing through a large cavity, as in pneumothorax.
Thoracic fluctuation	Air and fluid in a cavity, as in hydro-pneumothorax.
Friction murmurs .	Pleurisy.

Laryngeal Sounds.

Harsh	Obstructed larynx, paralysis or thickening of vocal cords.
Sonorous rhonchi .	Secretion in larynx.
Sibilant	Spasm of larynx.
Gurgling	Much secretion with want of power to expectorate.

DISEASES OF THE VASCULAR SYSTEM.

Pericarditis.—Inflammation of the pericardium most commonly occurs in the course of an attack of acute rheumatism or scarlet fever. It may, however, come on in the course of other specific fevers, apparently idio-

pathically, in Bright's disease, or may be due to local irritation from injury or new growths. If the presence of other symptoms does not mask those due to the pericarditis, we generally find that the patient complains of pain in the region of the heart, and that there is quickening and irregularity of the heart's action, rapid breathing, and a rise of temperature. Auscultation reveals a friction sound in the cardiac region, which does not cease when the breath is held. As the disease advances, serous fluid is usually secreted in considerable quantity, and the friction sound disappears; the heart sounds become faint and distant: if there is much diffusion, dyspnœa and cyanosis may become very marked; the area of cardiac dulness will become large, and of a pyramidal shape, with the apex upwards, while bulging may be felt in the intercostal spaces. If the effusion becomes puriform, or if it is pyæmic, the temperature is subject to sudden changes. Pericarditis may end in absorption of the fluid and formation of adhesions between the visceral and parietal layers of the sac, or the patient may die of suffocation, syncope, or of some visceral complications.

Treatment.—In cases not due to such irritants as tubercle, carcinoma, &c., poultices or blisters may be applied over the præcordium, while care should be taken to keep the patient propped up in bed, and hasty movements or exertion should be guarded against. In cases where the excess of fluid secreted threatens to stop the heart's action, it may be necessary to remove some of it by aspiration, an operation which must be done with much care, and with due consideration of the danger involved in it. Opium is useful to allay pain and as a sedative; if there is much prostration, alcoholic or other stimulants must be given.

Endocarditis.—The same causes which give rise to pericarditis may lead to inflammation of the endocardium. The valves of the heart are usually affected, most commonly on the left side, and the result is usually transient or permanent incompetence, or obstruction. The inflammation usually takes the shape of warty growths on the ventricular side of the valves. Sometimes the endocardium alone is attacked, leaving the valves untouched. Cicatrization may follow, or actual ulceration. The various effects of these lesions are best considered separately.

1. Embolism.—It frequently happens that in the course of acute rheumatic endocarditis, fragments of warty growths are detached from the valves and carried into the circulation. If one of these is carried to the brain, thrombosis and hemiplegia, more or less marked according to the size of the vessel obstructed, follow. In such cases, a branch of the middle cerebral artery on the left side is usually affected. Sometimes an embolus is carried towards the lower extremities, and by choking the femoral artery gives rise to gangrene of the lower limb. When carried to other parts, on account of the freer anastomoses of vessels, the effects are less serious. Chorea often follows or accompanies mitral disease, and has been ascribed to minute emboli being showered upon the vessels of the motor centres of the cerebrum. In ulcerative endocarditis the same effects may follow. In this condition the course of the disease is often very chronic, and is attended by rigors and septicæmic symptoms, often followed by hemiplegia.

2. Aortic Obstruction.—This is usually the result of cicatrization of tissue in the inflamed aortic valves. It is marked by increased action and hypertrophy of the left ventricle; a systolic murmur, heard best at the base of the heart, accompanies this condition. Besides being the result of acute inflammation, it often follows chronic inflammation.

3. Aortic Incompetence or Regurgitation.—This may arise from inflammation or from rupture of a valve from excessive exertion. It is the most serious form of valvular disease, and the one most likely to lead to sudden death. In this condition a diastolic basic murmur is present, usually conducted, half-way or further, towards the apex. The pulse is jerking and full, "water hammer," and the arteries in the neck and arm visibly pulsate, especially on excitement. Dilatation of the heart, with some hypertrophy, follows, and mitral incompetence frequently ensues. Incompetence and obstruction are often present together.

4. Mitral Incompetence or Regurgitation.—This is the commonest form of valvular mischief. It is usually accompanied by a well-marked systolic murmur, heard best at the apex and conducted towards the axilla. The pulse is small and feeble, the tissues are ill nourished, and the patient becomes cyanotic on exertion.

5. Mitral obstruction is occasionally observed. This

condition is accompanied by a thrill felt when the hand is placed over the apex of the heart, and by a murmur, presystolic in point of time, heard only at or near the apex of the heart.

As results of valvular disease we find usually malnutrition of all the tissues, frequent attacks of faintness, palpitation and shortness of breath. When the mitral orifice is affected directly or indirectly, and blood cannot freely escape from the lungs, pulmonary congestion occurs, congestion of the liver leading to nutmeg liver, obstructions to the vessels of the lower extremities and abdomen, giving rise to ascites and to œdema of the legs. Passive congestion from diminished force of the circulation also aids the exudation of serum into the tissues.

Direct lesions of the right side of the heart are of comparatively rare occurrence.

Treatment.—The tendency of valvular disease is nearly always to become worse; engorgement of the lungs and of the liver, ascites and general dropsy, close the scene, if the patient has not been carried off by some intercurrent disorder or by sudden failure of the heart's action. But much can be done to alleviate the patient's condition, although no cure can be effected. Rest and avoidance of excitement are of the first importance, and if these conditions can be obtained, in most cases a fairly long life can be hoped for. Digitalis is useful in most forms of heart disease; its action is to regulate and strengthen the heart's contractions, and it may be usefully combined with iron. In aortic regurgitation digitalis is said to act injuriously, by increasing the length of the diastole, and so lengthening the time during which regurgitation takes place; but even here there is good evidence that it is useful. Belladonna is sometimes given in such cases. Where there is much dyspnœa or faintness, stimulants, such as ether and ammonia, are required. To relieve cardiac dropsy the bowels should be unloaded, and the skin and kidneys encouraged to act; often when the patient is apparently overcome by serous exudations, much temporary benefit is gained by bleeding or by puncturing the legs or abdomen with fine trocars or needles, and allowing the fluid to drain away.

AFFECTIONS OF THE MUSCULAR SUBSTANCE OF THE HEART.

Like other organs, the heart may be the seat of new growths and degeneration; of these, the most common are the following:—

1. Fatty Infiltration and Degeneration.—In patients who are the subjects of general obesity the heart is often overlaid with excess of fat, and fat may also be deposited between the muscular fibres. Fatty degeneration of the fibres occurs in many fevers, typhoid for instance, and also in persons who are suffering from chronic Bright's disease, gout, &c. The main symptoms are enfeeblement of the heart's action, dyspnœa, palpitation, and tendency to syncope. Sudden death is often caused by failure of the heart's action in cases of fatty degeneration.

2. Myocarditis.—The heart may be the seat of acute inflammation in the course of acute rheumatism or Bright's disease; in pyæmia abscesses may form in its substance. The symptoms are cardiac irregularity, weakness of action, and tendency to death from syncope.

3. Tumours may form in the substance of the heart. The most common are syphilitic, tubercular, and malignant. They are difficult of diagnosis during life, and may cause sudden death from interference with the heart's action.

There is obviously no specific treatment for any of these conditions. It is important to observe that cases of cardiac fainting, common in advanced life, should be treated very differently to ordinary fainting attacks. Rapidly diffusible stimulants, such as ether and sal volatile, should be promptly given, and care should be taken to avoid over-exertion, heavy meals, or whatever may be likely to tax the action of the heart.

Angina Pectoris (Breast Pang).—These names, and Cardiac Neuralgia, have been given to a form of heart disease commoner among men than women, rarely found in persons under the age of forty years, and which is associated sometimes with ossification of the coronary arteries, sometimes with fatty degeneration of the muscles of the heart, sometimes with aneurism, and at other times with no discoverable lesion. The main symptoms are a feeling of intolerable oppression over the centre of the breast-bone, faintness, often complete, and, as the

patient often expresses it, "a feeling as if he were going to die."

During an attack the pulse becomes small and irregular, the surface of the skin cold and clammy, the face drawn and anxious. Pain shooting down the left arm most commonly attends the attack, but pain may also affect other parts of the body or limbs. The attacks are liable to be brought on by excitement, exertion, or heavy meals; they are prone to recur, and sooner or later to prove fatal.

Treatment.—A quiet and regular mode of life is essential. The patient should always have at hand some of the remedies which have proved useful in allaying the spasms. Among these, nitrite of amyl and nitro-glycerine are the most valuable. Nitrite of amyl should be used by placing four or five drops on a handkerchief or piece of blotting-paper and inhaling it, or it may be given internally. Nitro-glycerine is best given internally as a one per cent. solution in spirits of wine; one or two drops of this solution is a sufficient dose. Ammonia, ether, brandy, and other stimulants are useful, and the application of the Faradaic current has been tried successfully.

Cyanosis.—Cyanosis, or blueness of the surface of the skin, may arise from any cause which prevents the due aëration of the blood, or which leads to a mixture between the arterial and venous currents. Mitral disease, bronchitis, phthisis, and hooping-cough are thus often accompanied by cyanosis. Congenital defects are not uncommon, and when they are extreme, life is not usually very prolonged. The most frequent are :—Patency of the foramen ovale, the passage which in the fœtus leads from the right to the left auricle; patency of the ductus arteriosus, leading from the pulmonary artery to the aorta, just beyond where the left subclavian artery is given off; and imperfection of the septum between the ventricles. Sometimes, the heart being perfect, cyanosis occurs from imperfect expansion of the lungs, or atelectasis pulmonum. The congenital conditions are irremediable; those depending upon disease must be treated according to their cause.

Aneurism.—An aneurism is a dilatation of an artery, with or without the formation of fibrinous layers on its walls. Aneurisms commonly appear in men of middle age who have been in the habit of undergoing violent exertion, and whose arteries are weakened by atheroma

and fatty degeneration. It is common among soldiers, and syphilis seems in many cases to play some part in predisposing to it. Aneurisms vary much in size and shape. In the brain they are commonly small, while in connection with the large arteries of the thorax and abdomen they may attain a great size. Sometimes they are mere fusiform dilatations of the walls of an artery, or they may be globular in shape, with a more or less distinct mouth leading into the lumen of the vessel. The coats of the artery may all be represented in the wall of the sac, or the inner and middle coats may be ruptured, or the sac may be formed by the tissues around the vessel.

The results of aneurism are always serious, but vary according to the situation. In the brain they are liable to rupture, and thus produce one form of hæmorrhagic apoplexy. In the thorax, if the arch of the aorta or the large branches springing from it be affected, a large tumour may form, growing forwards, eroding the sternum and tissues in front, producing a pulsating tumour, which may ultimately rupture, and causing a variety of symptoms from interference with the trachea, œsophagus, and neighbouring nerves. If the first part of the arch is affected, the heart may be so seriously pressed on as to cause death, or rupture may take place into the pericardium, and so give rise to a fatal result. Aneurism of the descending portion of the arch is often difficult to diagnose. It may cause erosion of the vertebræ and violent thoracic pains; it may open into the œsophagus or larynx, and cause copious vomiting of blood or hæmoptysis, or it may rupture altogether internally.

Treatment.—The medical treatment of aneurism consists of rest in bed, a spare diet, with little fluid, and the administration of iodide of potassium. When the aneurism points externally, good results have been obtained by galvano-puncture, and various surgical methods of treatment have been more or less successful.

Anæmia (Chlorosis).—Anæmia, or poverty of the blood in red and white corpuscles, is found in Bright's disease, after profuse hæmorrhage, and in connection with wasting diseases. It is, however, not uncommon as an independent affection, and is then usually found in young women. The causes of it are not known, but it is often associated with menstrual irregularity, want of exercise in the open air, bad food, and bad hygienic conditions generally.

The symptoms associated with anæmia are loss of energy, want of appetite, indigestion, flatulence, constipation, headaches, drowsiness, and frequently ulceration of the stomach. The patient's face and mucous membranes are pale and waxy-looking, often the skin is of a yellowish tint, justifying the name of chlorosis.

Treatment.—The administration of iron in full doses is required in these cases. The perchloride and tartrate or sulphate of iron may be given, along with some vegetable bitter. Arsenic, in many cases, is more effectual even than iron. In some cases it may be necessary to give alkalies first to remedy the irritability of the stomach. The bowels should be kept freely open, and good food and regular exercise in the open air are essential.

PERNICIOUS ANÆMIA.—This is a fatal form of anæmia, which attacks men and women about the period of middle life. Its causes are wholly unknown. The symptoms are anæmia, languor, and persistent failure of strength. Digestion becomes imperfect, sickness is often constant and not amenable to treatment, the pulse is soft and rapid, and the temperature is apt to rise and continue one or two degrees or more above normal. The blood under the microscope is seen to be deficient in red corpuscles, and those which are present are frequently found hypertrophied, and to easily undergo changes of shape, being evidently softer and less resisting than normal. No constant changes are found in internal organs. It has been suggested that the disease is due to disease in the medulla of the bones, where red corpuscles are supposed to be formed; but if this is sometimes the case, it is not invariably so.

Treatment.—No treatment has been found serviceable. In some extreme cases of anæmia almost approaching to pernicious anæmia, arsenic has been found very useful; consequently, this drug may be tried.

LEUCOCYTHÆMIA AND LEUCÆMIA.—This is a form of anæmia in which the lymphatic glands are enlarged (lymphadenoma), or the splenic lymphoid tissue, or both glands and spleen. The blood is poor in red corpuscles, but rich in white. The white corpuscles due to splenic disease are of normal size; those found when the glands are affected are smaller than normal, and have been named microcytes.

The symptoms of leucæmia are pallor, palpitation, shortness of breath, and gradually increasing weakness.

The temperature is often febrile, and intercurrent diseases of the lungs and other organs are common.

No treatment has been found efficacious in stopping the course of the disease, which is generally fatal in from six months to two years when the spleen is affected, but is more chronic where only the lymphatic glands are diseased.

Goître.—Goître, bronchocele, or Derbyshire neck is an enlargement of the thyroid gland, due usually to simple hypertrophy, but sometimes cystic and sometimes pulsating from an over-abundant arterial supply. In many cases goître is clearly to be traced to local causes. It is often endemic where the drinking water contains magnesian limestone, and where the people live in valleys much shaded from the sun. The extent of the enlargement varies much. Women are more frequently affected than men, and in certain valleys in Switzerland goître is found associated with cretinism—a peculiar condition of want of development of body and brain. Sporadic cases of goître alone, or of goître with cretinism, are not infrequent.

The symptoms of goître are mainly due to pressure. Usually there is no pain, and the condition is not dangerous; but occasionally a rapidly growing goître will threaten death by suffocation.

Treatment.—If the patient is living in a limestone country, the water should be softened by boiling or distillation. Iodine as a local and internal remedy has obtained a considerable reputation.

The liniment of iodine may be painted over the surface, or the tincture may be injected into the substance of the gland. An ointment of biniodide of mercury, rubbed into the skin over the goître, with subsequent exposure to a hot sun, has been very successfully tried in India. If the goître is cystic, it may be punctured. Various surgical measures have also been tried for the relief of goître, including extirpation of the gland and ligature of the arteries.

Graves' or Basedow's Disease (Exophthalmic Goître).—In this condition the main symptoms are attacks of violent palpitation of the heart, tumefaction of the thyroid gland, and protrusion of the eyeballs, often to such an extent that the eyelids cannot be closed. It is observed mainly in young women, and is often associated with hysteria. The causes of this malady are very obscure, but there seems to be some reason to

believe that it depends upon some nervous disturbance, probably of the sympathetic system. The disease is often gradual in its onset, and is generally associated with disturbance of the general health, indigestion, flatulence, irregular menstruation, leucorrhœa, &c. During paroxysms the action of the heart is very violent, and the first heart sound is very loud. Graves describes a case in which he could hear it distinctly at a distance of four feet from the chest. The arteries of the neck pulsate visibly, while the radial pulse is weak and small, and the thyroid gland and eyeballs can often be seen to pulsate with each beat of the heart. Neither the exophthalmos nor the goître, however, can be looked upon as essential features of the disease, as they are often absent.

Treatment.—The general health of the patient must be improved. Digitalis and iron are often useful, and belladonna in five-minim doses every hour has been highly recommended.

Disease of the Supra-renal Capsules (Addison's Disease).—The supra-renal capsules may be the seat of cancerous or other tumours, but the most important morbid condition affecting them is tuberculosis leading to Addison's disease.

The symptoms of this disease are:—Pigmentation of the skin, commencing first in the neck and face, affecting most those parts which are naturally pigmented, but also appearing on the mucous membrane of the gums; attacks of sighing, yawning, and vomiting, and great prostration, mental and bodily; the circulation is languid, and the least exertion causes shortness of breath and cardiac faintness, so that the patient has to take to bed very early in the disease. At the same time the temperature is often rather subnormal, but the natural functions of the body are fairly performed. The conjunctivæ remain nearly white throughout.

The disease is commoner among men than women, and has been found at as early an age as nine or ten years, rarely in persons after the age of fifty years. It may be associated with phthisis or caries of the spine or general tuberculosis, but frequently is present in the absence of any other active disease. In its course remissions are frequent, but so far as is at present known it is always fatal; it may be so in a few months, or after as long as a year or two.

No treatment has proved of much avail.

Myxœdema.—This is a condition found in adult women, in which there is solid œdema of the skin, and probably of other tissues and organs. The new material has been found to be rich in mucin, hence the name myxœdema. The symptoms are mainly slowness of mental action, and sluggishness of movements. The face and hands are obviously swollen, but there is no pitting on pressure. All the natural functions are naturally, if slowly, performed. The course of the disease is very chronic, and ultimately fatal. No cause can be assigned for it, and no specific successful treatment is known.

Rickets (Rachitis).—This disease usually comes on in early life, about the period of weaning. Cases of late rickets occurring after the age of puberty have been observed. The causes of rickets seem to be chiefly improper food, bad air, and want of sunlight. The disease is very common among poor children in large towns, especially among those who are brought up by hand. Dr. West says he has never seen an infant while efficiently suckled by a healthy mother present any symptoms of rickets. The chief anatomical peculiarities of rickets are, softening of the bones, enlargement of their epiphysal ends and consequent deformities. The child becomes altered in other ways. It becomes dull and cries peevishly on being moved; the head seems too heavy for the body and rolls from side so side. Profuse sweating about the head occurs at night. The alimentary canal is always irritable, and exhausting diarrhœa is generally present. The aspect of a rickety child is characteristic. The legs become deformed, bowed or knock-kneed; the abdomen protrudes; the face is sallow and anxious; the head large, especially in the frontal region, and the cranial bones remain long separate at the anterior fontanelle. Chronic hydrocephalus is not infrequent, and convulsions often accompany this condition. The development of the teeth is retarded, and when they appear they are irregular, imperfect, and subject to early decay. Rickety children are often mentally extremely shrewd.

Treatment.—The main treatment is to reverse if possible all those conditions which have produced the disease. Give the child, if young enough to be suckled, healthy breast milk. If older, cow's milk, a little beef-tea, and occasionally underdone meat in small quantities should

form the staple diet, while farinaceous food should be added in small quantities. Pure air, sunlight, and cleanliness are essential. The bowels should be regulated, and cod-liver oil and iron are of great use as soon as the patient can assimilate them.

SCROFULA (STRUMA).—This condition is generally hereditary, and is commonest among the ill-fed, badly lodged inhabitants of towns. Scrofula is characterized by a tendency to enlargement of lymphatic glands and inflammation of lymphatic structures generally. The skin is liable to be affected with eczematous and other eruptions. The mucous surfaces suffer from chronic discharges, such as ozæna, leucorrhœa, otorrhœa, &c. The points often become acutely inflamed, and the bones suffer caries or necrosis. Later in life or early the patient is liable to fall a victim to pulmonary or general tuberculosis. The aspect of the patient may be heavy, the lips and nose thick, the skin sallow and unhealthy, and the mind slow and lethargic; or the skin may be clear, the aspect intelligent, the habit of mind vigorous and energetic.

Treatment.—The general treatment of struma consists of hygienic measures, of which the chief are fresh air and suitable exercise, and of the administration frequently of cod-liver oil and iron. The special local conditions must be treated as they arise.

DISEASES OF THE ALIMENTARY CANAL.

A. THE MOUTH AND PHARYNX.

Affections of the buccal cavity, besides giving rise to local discomfort, injuriously affect the general health by interfering with the free mastication of food, or by preventing the use of solid food altogether. The following are the chief local affections:—

1. Diseased teeth.
2. Ulcerations of the mucous membrane.
3. Abscesses.
4. Malignant growths.
5. Non-malignant growths
6. Tonsillitis.

1. THE TEETH may become carious from constitutional causes or mal-development, or from injurious articles of

diet and want of cleanliness. Abscesses about the gums are common, or especially if exposed to the fumes of phosphorus. Necrosis of the jawbones may follow dental caries. Under the influence of scurvy or mercurial poisoning, the teeth may become loose and drop out of their sockets. A fibrous tumour or epulis may form in connection with the alveoli. The result of any of these local diseases is to give rise to pain, and to interfere with mastication or swallowing. The treatment consists in removing the cause if possible.

2. Ulcerations.—Cancrum Oris is the most serious form of ulceration which can affect the cheeks. It most commonly occurs in unhealthy children after an attack of scarlet fever or measles. The disease commences on the mucous membrane as a patch of black sloughing tissue surrounded by an area of hardness on the cheek. The sloughs rapidly encroach on the surrounding parts, eating away the whole thickness of the cheek, exposing bones and teeth, until perhaps the whole side of the face is eaten away. The accompanying symptoms are those of extreme depression, and death is usually the result.

Treatment.—In the earlier stages the parts should be treated locally with strong nitric acid or the actual cautery; the parts must then be kept constantly clean with disinfectant solutions, and the general health kept up with tonics and stimulants.

Ulcerative Stomatitis.—This is also most common in children. The inside of the cheek or the gums are affected with an unhealthy ulceration, which destroys the mucous membrane: the surface of the ulcers are covered with a greyish white exudation which under the microscope is found to consist of pus cells, epithelium, and bacterial organisms. The condition seems infectious, as children using the same spoons or dishes are found to be attacked with the same disease on the same side of the mouth.

Treatment.—Absolute cleanliness and administration of a bland nutritious diet are the essentials of treatment. The mouth should be constantly washed with warm water, to which a little Condy's fluid may be added, and the affected parts may be painted with glycerine of borax, tannin, or some such agent.

Thrush, or Aphthous Stomatitis.—This is a condition found chiefly in infants who are being brought up by hand.

On the mucous membranes of the mouth and tongue, especially about the angles of the mouth, small white patches appear. These on being removed leave a raw or bleeding surface underneath, and on being examined are found to consist of the mycelium and spores of a fungus to which the name of *Oïdium albicans* has been given. Certain constitutional symptoms accompany, and are probably the cause, of this condition: the symptoms in the main are those of impaired nutrition and gastro-intestinal derangement.

Treatment.—If possible, the infant should be fed from the breast, and the bowels should be regulated. The mouth should be carefully washed each time food is taken, and borax and honey, or some astringent, should be occasionally applied with a brush or rag.

Syphilitic Ulcerations.—These may consist of chancres, cracks, or gummata softening into ulcers. The diagnosis is made from the appearances and history of the case. The treatment must be by anti-syphilitic remedies, constitutionally and locally.

3. Malignant Growths.—The most common of these is epithelioma. It usually occurs in persons between forty and fifty, and in places which have been irritated by a projecting tooth, a clay pipe, &c. The neighbouring glands are liable to be affected. The only treatment is early and complete extirpation.

4. Non-malignant Growths.—*Ranula* is a tumour met with in the floor of the mouth; its contents may be fluid or semi-gelatinous. It is a cystic formation arising in connection with, or independently of, a salivary duct. The treatment consists in laying the tumour open, or in passing a seton through it.

Glossitis is an acute inflammation of the tongue, which may end in abscess, or cause death by suffocation. When ordinary means of reducing the inflammation fail, recourse must be had to free incisions, or if asphyxia still threatens, tracheotomy.

Tonsillitis (Quinsy).—In this condition usually only one tonsil is inflamed and enlarged. If the condition is acute it may go on to suppuration. Tonsillitis may be due to scarlet fever or exposure to cold and wet, and there is generally a specific predisposition in those affected. The symptoms of an acute attack are fever, pain, and swelling at the angle of the jaw, difficulty in swallowing

and breathing. In chronic enlargement the patient's voice is affected, he sleeps with his mouth open and snores loudly, and may be troubled with more or less deafness.

Treatment.—In acute attacks hot applications should be placed at the angles of the jaw, the tonsils should be incised, and the bowels freely opened. Chlorate of potash, alum or lead gargles maybe used, and iron given internally. For chronic tonsillitis nitrate of silver may be applied locally, and cod-liver oil given internally. Often no relief is got except by cutting off part of the enlarged tonsil.

B. The Œsophagus.

The chief symptom produced by affections of the œsophagus is interference with swallowing. This may be caused by

1. Simple spasm, as in hysterical persons.
2. Paralysis.
3. Tumours pressing on the œsophagus from without, as enlarged thyroid, enlarged lymphatic glands in the neck, aneurisms, cancer or other tumours of the mediastinal glands, growths from the vertebræ, &c.
4. Œsophagitis. This may be caused by swallowing hot fluids, acids, &c., or may follow pharyngeal inflammation. An acute traumatic inflammation may end in ulceration and subsequent cicatrization.
5. New growths in the walls of the œsophagus, as syphilitic and cancerous tumours.

The diagnosis may often be made by examining the matters rejected and by passing a bougie. If a tumour is situated near the stomach a pouch is often formed above, which may retain a considerable quantity of food. If the stricture is complete, or nearly so, the patient quickly emaciates.

Treatment.—Food should be given by the mouth only in such quantities and form as may be assimilated. It may be necessary to feed the patient by enemata, and in some cases gastrostomy, or opening the stomach, has been tried with success. If the stricture is spasmodic or cicatricial, the regular passing of a bougie is useful.

C. The Stomach and Intestines.

Dyspepsia.—In every diseased condition of the body the working power of the digestive organs is more or less affected; therefore in all cases of dyspepsia careful search should be made for other diseased conditions. Where

dyspepsia is due to primary gastric disturbance the causes are mostly to be sought in errors of diet, excessive use of alcohol, irregularity in the action of the bowels, and want of exercise. The symptoms may be acute or chronic.

In *acute gastritis* the patient suffers from pain in the epigastrium especially on taking food, headache, giddiness, sickness and vomiting. The tongue is foul and coated, the bowels are usually constipated, and there may be more or less febrile disturbance. Flatulence and pyrosis are generally present, in young children convulsions are common.

In *chronic gastritis* there is usually no fever; pain between the shoulders and in the side is often complained of; the heart is liable to attacks of palpitation, especially at night; flatulence is often extremely troublesome, and there may be nausea or vomiting or pyrosis. During an attack the patient is always much depressed in spirits, and takes the gloomiest views of everything. The tongue is generally foul and may be thickened, indented with the teeth at the sides, or thin, red, and irritable; constipation or irregularity of the bowels is nearly always present; generally the appetite is lost, but sometimes there is a craving for food, which however only intensifies the mischief.

Treatment.—The main indications of treatment are to remove offending matter, and to give the stomach and intestines rest. Vomiting, if excessive, must be directly met by sedatives or counter-irritation over the epigastrium; bismuth, opium and hydrocyanic acid are the most useful drugs for this purpose; ice also may be sucked, and the patient should be kept at rest. The diet should be very carefully supervised, and at first milk and soda-water or lime-water, or beef-tea in small quantities, should alone be given. As the symptoms subside a little broth, fish or mutton may be gradually added to the diet. Alcohol should not be allowed as a rule, and tea and coffee should also be struck out of the dyspeptic's dietary. An alkaline tonic may afterwards be given before meals; the bowels must be regulated; the use of the cold bath daily and regular exercise in the open air, combined with regular meals of suitable food, will do much for chronic dyspepsia.

Gastric Ulcer.—Ulcers are frequently found in the stomach, either single or multiple; they are most frequently found on posterior surface, near the pyloric end, but may occur in any part of the mucous membrane.

Ulcers occur most commonly in persons who are anæmic, from whatever cause, and are very commonly found in young chlorotic females.

Symptoms.—The symptoms at first are mainly those of dyspepsia—viz., flatulence, nausea, sickness, discomfort on taking food, &c. Pain often of an intense boring character, aggravated or only present when food is taken, becomes a prominent symptom, and generally at some time or another blood is vomited and passed with the stools. The course of the disease is long; the ulcer may cicatrize, or death may result from excessive or frequently repeated hæmorrhage, or from perforation.

Treatment.—To check hæmorrhage and vomiting little bits of ice may be sucked and swallowed. Bismuth and hydrocyanic acid are useful drugs, and morphia or opium may be given when pain is excessive. The patient should be kept much at rest, and the diet should be restricted to milk and beef-tea, in small quantities, and given cold. In extreme cases nutrient enemata may have to be given. As the symptoms subside iron may be given and the diet gradually improved.

Diarrhœa.—Diarrhœa is a common accompaniment of some of the acute, specific, and other diseases. When it occurs from uncomplicated intestinal trouble, it may be due to injurious articles of diet, to chills, and to sudden changes in temperature; it is sometimes directly caused by nervous influences, as in sudden fright. In young children it is common about the period of dentition.

The symptoms consist of the passing of unformed motions more or less frequently, pain in the abdomen, tenesmus, and, where the diarrhœa is extreme, great depression. Among young children this condition is often fatal.

Treatment.—If there is any offending matter in the alimentary canal, some castor oil may be given to promote its expulsion; afterwards various astringents may be administered. Of these, chalk and opium, sulphuric acid and opium, and bismuth in large doses, are among the most useful remedies. The diet is of great importance, and should at first be restricted to cold milk and lime-water, or a little broth or beef-tea.

Intestinal Obstruction.—Obstruction of the intestine may be caused by—

1. Obstacles within the canal.

2. Narrowing of the wall of the gut by stricture, tumours, &c.

3. Agencies acting outside the wall of the gut.

Among the first class of causes we find accumulation of fæces, foreign bodies, such as a large gall-stone, or concretions arising from matter taken into the body (*e.g.*, prolonged use of magnesia, even in the fluid form), polypi, &c.; among the second class we find syphilitic and other tumours in the wall of the gut, fibroid thickening and cicatrization of ulcers; among the third class are the various forms of hernia, internal and external, twisting of gut, formation of bands across coils of intestine; intussusception of the bowels also comes under this head.

Obstruction may be acute or chronic. In the former case the symptoms are usually those of great injury to the abdominal organs, and consist of a more or less sudden attack of pain, of tympanitic swelling of the abdomen, of collapse, of vomiting finally becoming stercoraceous, and of obstinate constipation. This class of cases is generally due to strangulated hernia, twisting of the gut, or other sudden seizure affecting the intestine.

In chronic obstruction the symptoms come on gradually. The bowels are usually constipated, but frequently there is irritable diarrhœa, and the motions when solid are often slender and tape-like, and if there is a cancerous growth there may be extreme cachexia; in any case the patient is apt to have an earthy complexion. Blood may be passed; this is especially the case in intussusception. As the condition advances complete constipation follows, with vomiting at first of food, then of bile, then of fæcal matter.

Treatment.—Careful search should be made at all the apertures where a hernia is likely to occur, and examination should be made per rectum and by palpation, to ascertain if any solid obstructive material is in the gut. In acute obstruction opium should be given to allay pain and fruitless peristaltic action of the intestine. If a hernia is found, that must be reduced, and if there is reason to believe that internal strangulation has occurred, the abdomen may have to be opened. In cases of chronic obstruction care should be taken to keep the fæces fluid if possible; obstructing matter may be removed by enemata, or may have to be scooped out of the rectum. The late Mr. Henry Hancock was accustomed to give drachm doses

of liquor potassæ freely diluted with hot tea, for the purpose of rendering the fæces fluid in the various forms of chronic obstruction.

Ulceration of the Intestine.—Ulcers may occur in any part of the intestinal canal, and in some diseases are constantly found, as in typhoid fever, dysentery, tuberculosis and syphilis. Ulcers may also be caused by foreign bodies, and in the duodenum they often arise in the class of patients which suffer from gastric ulcer; another curious duodenal ulcer is that associated with severe surface burns, and which is liable to come on about the tenth day after the injury.

Symptoms.—Excluding ulcer due to specific diseases, the common symptoms of ulcer of the intestine are pain and tenderness, increased by the presence of food, vomiting, and sometimes the passage of blood with the stools. A not uncommon result is perforation of the gut. When this happens acute peritonitis may be set up, or if there has been preceding inflammation, small localized abscesses or cyst-like cavities communicating with the alimentary canal may be formed. The cæcum and vermiform appendix are common seats of inflammations like these, and the conditions are then known as typhlitis; when there is no perforation, perityphlitis, an inflammation of the loose cellular tissue round the cæcum, may arise. Similar conditions are not uncommon in and round the rectum, proctitis, and in and round the duodenum.

Treatment.—For simple ulceration the main treatment consists in keeping the intestine at rest by only giving liquid food, and in giving bismuth and opium or other sedatives. In perityphlitis the abscess, if it points externally, should be opened; the matter discharged is always peculiarly foul and contains fœtid gases; for local inflammation, rest, the application of warmth, and the administration of opium are required.

Peritonitis.—Inflammation of the peritoneum may be caused by direct injury, exposure to cold and wet, perforation of the intestines, rupture of abscesses and abdominal cysts, or in connection with general or local tuberculosis. It may be chronic, acute, or subacute.

In acute or subacute peritonitis the local symptoms are pain and tenderness over the inflamed area, tympanites, and constipation. The tongue is furred, the mouth generally foul, the pulse is rapid, weak, and wiry, and the temperature is raised. In chronic peri-

tonitis there is more or less abdominal pain and tenderness, the bowels are generally constipated and distended with gas, and there may be a great or slight accumulation of fluid in the peritoneal cavity.

The course of the disease may be very rapid, and end in complete recovery or in collapse and death, or it may in the chronic form go on for months.

Treatment.—The patient should be kept in bed lying on his back, with the knees propped up so as to protect the abdomen from the weight of the bedclothes and relax the abdominal muscles. Leeches may be applied to the skin, or hot applications and counter-irritation with turpentine or other rubefacients may be used. Opium in sufficient doses to check pain and procure sleep should be given. If there is much sickness, iced milk in small quantities only should be given, or food may be given by enemata. In any case the diet should be given in a fluid form.

INTERNAL PARASITES.

NEMATOIDEA.—These are round worms with a well-developed alimentary canal and generative apparatus. Those which are found in the human body are—

1. The ascaris lumbricoides. These are worms from five to ten inches long. They are usually found in the small intestines, are rarely numerous, and are sometimes vomited, sometimes passed with the stools.

2. The oxyuris vermicularis. These are small round thread-like worms, usually present in great numbers in the lower part of the large intestine.

3. The trichina spiralis. These worms have two stages of existence—a sexual and an asexual. In the sexual state they are found in the alimentary canal of man, the pig, and other mammals. The young trichinæ, born in great numbers, bore their way through the walls of the gut and enter the fibres of the voluntary muscles, say of a pig, where they become encysted. "Measly" pork is thus produced, and this being eaten by man, the young trichinæ acquire their sexual state in his alimentary canal, and pour their brood into his muscles.

4. Filaria sanguinis hominis. This has been noticed in connection with chyluria.

THE CESTOIDEA OR TAPE-WORM.—These worms have two states of existence—a cystic and a cestoid or worm-like. The former is asexual, the latter sexual. The cystic form

consists of a head provided with suckers and hooklets above the suckers ; below, the body consists of a spheroidal sac, into which the head can be retracted. The cestoid form has the same kind of head, but developed from it are numerous segments or proglottides, which each contain male and female generative organs, and develop the ova of the parasite.

As a rule the cestoidea require two hosts, living in one in the cystic and in the other in the cestoid form. The following Table, taken from Huxley, shows the second hosts of those found in man :—

Cystic Form.	*Cestoid Form.*
Cysticercus cellulosæ: muscles of pig, eye, brain, &c., of man.	Tænia solium : in intestine of man.
Cysticercus (?) muscles of ox.	Tænia mediocanellata : in intestine of man.
Echinococcus hominis : liver and elsewhere in man.	Tænia echinococcus: in intestine of dog.

Symptoms and Treatment.—Nematoid worms found in the intestine give rise to some irritation, and in children often to convulsions. They are best got rid of by the administration of santonin or other vermifuges, followed by a purgative. Salt-water injections are very useful, and the use of some form of iron is generally indicated. Tape-worms may give rise to discomfort, but often only indicate their presence by the appearance of segments or proglottides in the stools. They are best got rid of by the administration, while fasting, of extract of male fern, turpentine, or kousso infusion, followed by purgatives. The *tænia solium* has a small head, with twenty to thirty hooklets arranged in two rows, and four suckers. The segments can be recognized by the common openings of the male and female generative apparatus, which is situated at the opposite sides, in alternate segments. The *tænia mediocanellata* has a flat head without hooklets, but with four suckers. The common opening of the generative organs is near the posterior border of each segment. The *bothriocephalus latus* has a club-shaped head grooved laterally, and provided with two suckers. The segments have each two openings, one for the male and one for the female apparatus.

The symptoms to which the cystic form give rise are

often very serious, but vary according to their seat. The trichina spiralis gives rise to trichinosis, which is marked by fever, bodily pains, tenderness, and rigidity of the limbs, with much weakness. Often death ensues, or the worms may become encysted and die, and a prolonged convalescence ensues.

DISEASES OF THE LIVER AND BILE-DUCTS.

Peri-hepatitis.—Inflammation of the capsule of the liver may be acute or chronic. Chronic peri-hepatitis is somewhat common; its causes are obscure, but it has been found after exposure to cold and wet, after peritonitis or other inflammation of neighbouring parts, and associated with alcoholic excess and syphilis. Its effect is to compress the liver, often causing it to assume an almost globular form.

Symptoms.—Peri-hepatitis is a very common cause of ascites; in addition it gives rise to pain in the hepatic region, gastric catarrh, and other phenomena associated with cirrhosis.

Cirrhosis of the Liver (Hob-nailed Liver).—This condition depends usually upon a chronic inflammation of the connective tissue round about the portal vessels. At first the liver is enlarged by the proliferation of the cell element, but as the disease continues it becomes contracted, and from puckering of the surface assumes the characteristic hob-nail appearance. Cirrhosis of the liver has been attributed to the excessive use of alcohol, especially gin and brandy, but many cases occur in which there is no trace of such indulgence; well-marked cases have been seen in quite young children.

Symptoms.—The early symptoms are usually obscure, consisting mainly of a feeling of discomfort in the hepatic region, and more or less acute gastric catarrh. As the disease advances, the stomachic and intestinal symptoms become more marked. As the portal circulation is more or less blocked, hæmorrhages from the stomach and by the bowel come on, and the hæmorrhoidal veins become enlarged and painful. Vomiting is frequent; the superficial abdominal veins become enlarged; and lastly, ascites sets in. Jaundice is rare, or, if present, is slight. Death usually occurs from gradual loss of strength, or may come on from profuse hæmorrhage.

Treatment.—If excessive use of alcohol is the cause, this must be stopped. The bowels should be kept freely

open, and the food should be light and easily digested. If the ascites is great, occasional tapping will relieve the patient for a time, although the fluid is sure to accumulate again.

HYPERTROPHIC CIRRHOSIS.—In this form of cirrhosis the liver is enlarged throughout the whole course of the disease by the infiltration round the capillaries of the bile-ducts of embryonic connective tissue, which tends gradually to replace the lobular and interlobular tissues. The liver is much enlarged, smooth, and yellowish on section. The disease is a chronic one, and is mainly confined to adult life.

Symptoms.—As in atrophic cirrhosis, there is much gastro-intestinal disturbance and loss of strength. As the disease affects mainly the bile-ducts, jaundice from obstruction is a constant symptom. Ascites and hæmorrhage are usually absent.

Treatment.—This must be directed mainly to alleviating the gastric catarrh, and supporting the patient by a light, unstimulating diet.

ACUTE YELLOW ATROPHY (MALIGNANT JAUNDICE).—This is a disease characterized by sudden inflammatory degeneration of the cells of the liver. It comes on in adults, frequently in pregnant women, and is much more common in women than in men. The liver rapidly atrophies, and the structure of the liver cells becomes destroyed.

Symptoms.—In pregnant women the premonitory symptoms are excessive vomiting and depression; in other cases there may be no premonitory stage. As soon as the disease has declared itself, there are marked signs of blood-poisoning; the patient becomes delirious, the delirium being furious or of a low type, or has convulsions; the pulse is quick and feeble, the tongue coated, the bowels confined, and the urine is scanty, coloured with bile, and shows crystals of leucin and tyrosin under the microscope. Jaundice is present, but is never excessive. Hæmorrhage under the skin and from mucous surfaces come on. The temperature does not rise. Death usually ensues in from a few hours to four or five days.

The same series of symptoms are sometimes seen in phosphorus poisoning, but in these cases the liver is enlarged and fatty.

Treatment.—The only treatment that has been sug-

gested is in the case of pregnant women, where the procuring of abortion has sometimes appeared to check the disease. In other cases all that can be done is to endeavour to check vomiting, and to procure free action of the skin and bowels.

Gall-stones (Biliary Calculus).—The causes of the formation of gall-stones are obscure. The stones may form in the gall-bladder or bile-ducts; their size and composition is very variable. Sometimes they are few in number, but more commonly many are present; they may be so small as to form gravel, or as large as a hen's egg. In composition, they may consist mainly of bile-colouring matter; often they are formed mainly of cholesterine; others are calcareous or laminated, the different layers varying in composition.

Symptoms.—The effects of gall-stones may be thus classified:—

1. They may never give rise to any abnormal symptoms.
2. They may give rise to inflammation leading to abscesses, which may open externally or internally, or adhesive inflammation may occur between the gall-bladder or duct and the duodenum, and the stone or stones may ulcerate through.
3. In their passage down the bile-duct they may block it up, giving rise to intense obstructive jaundice.
4. They frequently give rise to attacks of intense pain (biliary colic) in passing into the intestine.
5. A large calculus in the intestine may give rise to complete or partial intestinal obstruction.

Of these symptoms the commonest are colic and jaundice. Biliary colic is marked by intense pain in the region of the liver, accompanied by great prostration, vomiting, and frequently jaundice. If the obstruction is complete, or if there is much inflammation of the bile-duct set up, jaundice may be intense, and the motions passed are pale, oily, and offensive. It is said that stones from the gall-bladder are most likely to pass into the duct an hour or so after a meal, when the flow of bile into the intestine is most active. The pain ceases, leaving much soreness, if the calculus passes into the intestine or slips back into the gall-bladder.

Treatment.—During an attack of colic sedatives should be given to ease pain and check spasm of the duct. Hot applications over the liver are also useful. Drinking

large draughts of hot water is highly spoken of. If an abscess forms and points externally, it should be opened, although a biliary fistula will likely be formed. In complete obstruction of the duct or intestine, the only hope of saving life may be in an operation. Between attacks the general health should be attended to, and all excess in eating or drinking avoided.

Catarrh of the Bile-ducts.—This is one of the commonest causes of jaundice. It may arise from exposure to cold and wet, irritation of some foreign body, or, what is most frequent, gastric and duodenal catarrh extending into the orifice of the duct in the duodenum.

Symptoms.—These are at first those of gastric catarrh, nausea, sickness, constipation, and flatulence. When the duct becomes obstructed jaundice sets in, and if the obstruction is prolonged and complete the gall-bladder enlarges, so that it can be felt as a fluctuating tumour in the right hypochondrium. Great pain is generally complained of, as in hepatic colic, with tenderness over the liver. Later symptoms of biliary toxæmia set in, and death may come on from gradual weakness or from some intercurrent disorder.

Treatment.—When the catarrh is secondary to intestinal trouble, the treatment must be mainly directed to that. Food as free as possible from fatty matter should be given, and in a liquid form. Alkalies, with hydrocyanic acid and some vegetable bitter, may be prescribed. Warm applications and counter-irritation over the epigastrium are useful. The kidneys and skin should be encouraged to act.

Abscess of the Liver.—Abscesses of the liver may occur from the following causes:—

1. Pyæmia.
2. From the suppuration of a hydatid sac.
3. Following ulceration of the intestines.
4. In association with (preceding or following or accompanying) dysentery.
5. Apparently idiopathic.
6. From injuries.

Abscess in the liver, as elsewhere, is marked by rigors, a fluctuating temperature, tenderness and œdema of the skin if the abscess points externally. In addition, if the abscess affects the gall-bladder or duct there may be jaundice.

If due to pyæmia the abscesses are usually multiple.

Tropical abscess, or acute hepatitis, is predisposed to by degeneration of tissue, brought about by great heat or malarial influences, and may be associated or not with dysentery. Usually, the tropical abscess is single. In temperate climates hepatic abscesses are sometimes found without any obvious cause.

Hepatic abscesses may travel in any direction. Sometimes adhesions are formed with the diaphragm, next with the superjacent lung, giving rise to a localized pneumonia, and the abscess may burst into the lung and the pus be discharged by the air-passages; or the abscess may open into the pleural sac, forming an empyema. In other cases the abscess may burst into the peritoneum, setting up fatal peritonitis; or adhesions may form with the intestine, and the pus may be discharged into the alimentary canal. In more favourable cases it may point externally, or, more rarely, the pus may be dried up into a putty-like or calcareous mass, become encapsuled, and give no further trouble.

Treatment.—The only treatment offering hope of a successful result is to open the abscess externally when adhesions are formed between the liver and abdominal or chest walls. Multiple abscesses generally offer little chance of successful treatment.

Tumours and New Growths.—Any form of tumour or new growth to which other parts of the body are liable may be found in the liver, frequently as secondary deposits. Those commonly found are the following:—

1. Hydatid tumours.
2. Sarcomata.
3. Carcinomata.
4. Tubercle.
5. Syphilitic gummata.
6. Amyloid infiltration.

A hydatid tumour is not necessarily attended with any obvious symptoms. If it is posterior it may not be possible to diagnose it; if it is situated anteriorly, it is found to give rise to a growing, irregular, fluctuating tumour, which, when the hand is placed over it and percussed, yields the hydatid fremitus. If the growth presses upon the bile-ducts it may give rise to jaundice. Sometimes it suppurates, or it may rupture into the abdomen or thorax. If it is near the surface, it can be diagnosed by using an aspirateur or fine trocar, and drawing off some of the clear fluid which the cyst contains; or, if the

trocar is large enough, hydatids or hooklets may be thus obtained.

Sarcomata, when present, are usually found in other situations as well; the same can be said of cancer. Both these diseases give rise to well-marked constitutional symptoms.

Tubercle and syphilitic gummata are usually found only as part of general tubercular and syphilitic infection. Amyloid disease occurs under the same conditions as in the kidney. This is essentially an infiltration following the course of the smaller arteries, affecting their walls, and finally reaching the inner cells, which become enlarged, rounded in contour, fatty, and functionless.

Treatment.—For a hydatid cyst the best treatment is aspiration, or emptying of the sac with a fine trocar and canula, so as to avoid any chance of escape of the cyst contents into the peritoneal cavity. Electrolysis has been tried with good results. In syphilitic growths, either iodide of potassium or mercury must be given. In the other tumours and new growths no treatment is of any avail.

Diagnosis of Diseases of the Liver.—The following appearances and symptoms occur in affections of the liver and its ducts and vessels:—

1. Enlargement.
   Causes. Cirrhosis, first stage.
   Hypertrophic cirrhosis.
   Fatty liver.
   Amyloid liver.
   Congestion.
2. Irregularity, with or without enlargement.
   Causes. Distended gall-bladder.
   Hydatid tumour.
   Malignant or other new growths.
3. Atrophy.
   Causes. Cirrhosis, advanced stages.
   Peri-hepatitis.
   Acute yellow atrophy.
4. Jaundice.
   Causes (*a*). Obstruction due to catarrh of bile-ducts.
   Gall-stones, or other foreign bodies.
   Tumours pressing on bile-ducts.
   Cirrhosis (jaundice slight).
   Hypertrophic cirrhosis.
   (*b*). Non-obstructive, due to acute yellow atrophy.

Poisoning by phosphorus.
Specific fever, such as yellow fever, ague, &c.
Mental shock.
Deficient aëration of blood, as in icterus neonatorum.

5. Hæmorrhage from the stomach or bowels, hæmorrhoids, enlargement of superficial veins of abdomen and thorax.

Causes. Cirrhosis.
Pressure on portal vein or its tributaries.

6. Ascites.

Causes. Peri-hepatitis.
Cirrhosis.
Obstruction to portal vein from tumours.

URINARY DISEASES.

Examination of the Urine.

1. Quantity Passed.—A healthy adult passes, on an average, 50 to 60 ounces in twenty-four hours.

2. Reaction to Test Paper.—It is normally acid when passed, increases in acidity for an hour or two after it leaves the body, and on exposure to air for a few days (time varying much) becomes alkaline from the change of urea into carbonate of ammonia.

3. Specific Gravity.—Normally from 1015 to 1025, but may in health be occasionally above or below these extremes.

4. Appearance.—Healthy urine is a clear, amber-tinted fluid when passed. In cold weather and after heavy meals urine on cooling may become thick from the presence of urates of soda, &c., without any departure from health; this thickness disappears at once on heating the urine.

5. Chemical Characters.—Constituents of healthy urine, in 1,000 parts :—

Water	967
Inorganic salts and other solids	33
Carbonic acid gas.	

The salts are sodium chloride (the most abundant), acid sodium phosphate (to which the acidity of urine is

due), potassium, magnesium and calcium, combined with chlorine, sulphuric acid, phosphoric acid, &c.

The organic matters include urea or $(NH_2)_2CO$ (about 14 parts in 1,000), uric acid or $C_5H_4N_4O_3$ (·468 in 1,000), and allied nitrogenous bodies, pigment, mucus, minute quantities of pancreatic and gastric ferments, &c.

The above are the characteristics of the urine in health. Any of these features may be departed from in disease. The following Table indicates the chief abnormalities to be found in the urine and their causes:—

1. Little or no urine may be passed.

   Causes.—Suppression: From organic disease of the kidneys (acute Bright's, &c.)

   Retention: Calculi in urethra. Stricture. Enlarged prostate. Paralysis of bladder.

2. Excess of urine may be passed.

   Causes.—Chronic Bright's disease.
   Contracted granular kidney, amyloid kidney.
   Diabetes insipidus.
   Diabetes mellitus.

3. The reaction may be alkaline.

   Causes.—An excess of vegetable food, or of alkaline drinks.
   Cystitis, with retention of urine in the bladder.

4. The specific gravity may be increased.

   Causes.—Diabetes mellitus.
   Acute Bright's disease.
   Amyloid kidney (occasionally).

5. The specific gravity may be decreased.

   Causes.—Diabetes insipidus.
   Contracted granular kidney.
   Amyloid kidney (generally).

6. The urine may be thick or discoloured, when passed.

   Causes.—Presence of pus, due to: Pyelitis, Cystitis, Urethritis, Peri-nephritic or other abscesses.

Causes.—Presence of blood, due to
- Calculi,
- Injuries,
- Acute Bright's disease,
- Villous growths in bladder,
- Scurvy, &c.,
- Irritant drugs.

Blood-colouring matter, due to
- Hæmoglobinuria,
- Hæmatinuria.

Bile from
- Injuries to the liver,
- Various forms of jaundice.

Mucus and phosphates from cystitis.
Presence of chyle, as in chyluria.
Presence of bacilli—Bacilluria.

7. The urine may contain albumen or sugar.

Acute Bright's Disease—desquamative nephritis.

Causes.—An attack of this disease is usually caused by exposure to cold and wet, or it occurs in the convalescent stage of scarlet fever, in erysipelas, small-pox, diphtheria, and other fevers.

Pathology.—The parts of the kidney affected are the glomeruli, the convoluted tubules, and the straight tubules. The glomeruli become the seat of an exudation of serum, white and red corpuscles. This exudation may choke up the space between the blood-vessels and the capsule, giving rise to suppression of urine or other serious symptoms, and after death no changes may be found in the tubules; this is the glomerulo-nephritis of Klebs. More often the convoluted tubes become affected; the epithelial cells in them become swollen, clear spaces appear in their substance which burst into the lumen of the tubes and discharge an albuminous fluid, the cells apparently secreting albumen from the blood and passing it on to the urinary channels (Cornil); later on, changes take place in the epithelium of the straight tubes leading to desquamation. In many of the acute specific fevers minute organisms have been found in the blood, and to these has been assigned a special irritant action giving rise to the vascular disturbances of the glomeruli. Accompanying these changes the kidney is found to be actively congested; leucocytes are also found in abnormal number in the parenchymatous tissue of the organ. Professor Cornil, who has recently described the changes he has observed in induced and natural nephritis, sums up the facts which pathological histology has taught regarding

these conditions as consisting in—1st, the passage into the urinary channels of serum, carrying with it red corpuscles and leucocytes; 2nd, a secretion from the cells of the convoluted tubes; and 3rd, pathological modifications of these cells. He considers the catarrhal or desquamative phenomena in the straight tubules as events of altogether secondary importance.

Symptoms.—In acute Bright's disease arising from exposure to cold, or coming on during convalescence from disease, the prominent symptoms are pain in the loins, shivering, rise of temperature, and frequency of micturition, the urine passed being small in quantity, smoky from the presence of blood, full of albumen, and of high specific gravity; anasarca usually appears early. The urine, when examined microscopically, is found to contain, besides blood, casts of the tubules and renal epithelium. Other symptoms may present themselves; œdema of the lungs giving rise to cyanosis and difficulty of breathing, palpitation of the heart, pericarditis or endocarditis, sickness; and if the secretion of urine is stopped, convulsions of an epileptiform character may come on from uræmic poisoning. Death may occur from œdema of the glottis or lungs, from heart complications, or from uræmic coma and convulsions due to blood-poisoning; the disease may become chronic, or under favourable conditions may subside altogether.

Treatment.—In the early stages of the disease the patient should be kept in bed, and warm applications or other means of counter-irritation, such as dry cupping over the loins, should be used. The skin and bowels should be encouraged to act, and the diet should be light and contain little nitrogenous matter. Opium and mercury should especially be avoided. Digitalis is useful, and with a good deal of pure water or preparations of acetate of potash or citrates will be found useful, in acting as a diuretic to clear the clogged-up tubules. Later on the perchloride of iron is the most useful drug for the anæmic condition. The duration of the disease may be from a week or two to many months, and the greatest care during convalescence and afterwards must be used to prevent a relapse. Alcohol should be avoided, the diet should be light and regular, and good warm clothing should always be worn.

Chronic Bright's Disease.—Three well-marked varieties

of morbid kidney are found associated with chronic Bright's disease—viz.:

1. The large white kidney.
2. The granular contracted kidney.
3. The amyloid kidney.

The large White Kidney.—In this form of chronic disease the kidney is found to be enlarged, smooth on the surface, pale and softer than normal. The tubules are the seat of fatty degeneration, and the interstitial tissue is infiltrated with small cells. The large white kidney is often the result of acute Bright's disease, or the inflammation may be subacute from the first.

Symptoms.—The patient is anæmic and generally has frequent attacks of anasarca; the face especially being often markedly puffy and œdematous. There is general loss of strength and assimilative power; the urine is rather less in quantity than normal, and contains albumen in varying amounts, tube casts and renal epithelium; its specific gravity is not much affected. There is a great liability to acute or subacute attacks of renal inflammation, and intercurrent disorders of the lungs and heart are very common. Sickness, giddiness, and apoplectiform attacks are also common.

Treatment.—The main lines of treatment are the same as in the later stages of the acute disease. Perchloride of iron is the most valuable drug, and this should be administered as well as occasional diuretics. The diet and habits of life are all-important. Much improvement has been noticed under an exclusively milk or skim-milk diet. When the anasarca becomes excessive this symptom may be temporarily relieved by puncturing the legs with ordinary needles, or with Dr. Southey's trocars. To prevent sloughing, it is advisable when needles are used to apply some antiseptic absorbing substance; sponges soaked in salicylic acid may be used for this purpose.

Contracted Granular Kidney (Gouty Kidney).—In this form of chronic Bright's disease the kidneys are much reduced in size. The causes and course of atrophy are at present the subject of dispute, but the condition is found in connection with the following conditions—viz.:

1. Following chronic inflammation which has produced a large white kidney; here the contraction of the inflammatory interstitial products leads to atrophy.
2. Associated with gout and lead-poisoning.

3. Associated with alcoholic excess, the kidney may be pale and fatty, or red (red granular kidney); cysts are often found arising from blocking of Malpighian capsules or portions of the renal tubes; these may be any size, from microscopical structures to cysts, so large as to form tumours which can be felt externally; the capsule is usually firmly adherent to the coats, but in some cases peels off readily. Under the microscope the intertubular substance is seen to be increased, the muscular coats of the arteries are thickened, and the tubules and Malpighian corpuscles are compressed and atrophied, while their lining cells are degenerated. Throughout the body the walls of the arteries are thickened, and the walls of the left ventricle of the heart are much hypertrophied.

Symptoms—The symptoms usually are obscure at first. There is general loss of strength and health; the urine is increased in quantity, so that the patient has often to get up several times in the night to pass it; it is of low specific gravity, and may or may not contain albumen. Puffiness of the face or ankles may come on to a greater or less extent. The face is pale and the skin generally harsh and dry. Cerebral hæmorrhage is likely to occur as well as hæmorrhages in other situations, especially the nose, stomach, bowels, and retina. Headache, giddiness, and sickness are also common in this form as in the large white kidney.

Treatment.—This in the main is the same as for the previous form of Bright's disease. The course of the disease is usually long, and with care life may be prolonged for many years.

Amyloid Kidney (Waxy or Lardaceous Degeneration).—The amyloid kidney is larger than normal, heavy, anæmic, smooth, and on section cuts like a piece of cheese. On the addition of tincture of iodine, the vessels of the Malpighian bodies and the smaller arteries are stained a deep mahogany colour so as to be clearly mapped out from the rest of the organ. The disease depends on the infiltration into the walls of the arteries of a material having the composition of the fibrin of the blood when deprived of its potash salts, de-alkalized fibrin. Amyloid disease of the kidney is always associated with similar disease in the liver, spleen, and bowels, and occurs almost invariably in the course of some prolonged wasting disease, such as caries of bones, abscesses, phthisis, and syphilis.

Symptoms.—There is always an excess of urine passed

throughout the whole course of amyloid disease. The specific gravity is usually rather low (1012 or higher), but has been observed to be very high at times, reaching 1030, 1046, 1065, in recorded cases; it is albuminous, often contains casts, and the excretion of urea is about normal.

Treatment.—No special treatment beyond that demanded by the primary disease is called for.

Renal Calculi, and Gravel.—Small stones sometimes form in the pelvis of the kidney which are discharged with the urine as gravel, with varying amounts of disturbance and pain. Frequently one of these concretions becomes lodged in the pelvis and grows to a large size, or reaches the bladder where it increases and forms a vesical calculus.

The uric acid calculus is very common in gouty and rheumatic subjects. Urates of ammonia, &c., often form in the kidneys of young children. The oxalate of lime or mulberry calculus is rough, very hard, and dark-coloured. The phosphatic calculus is white and friable, and usually forms in the bladder; often on a nucleus or some other substance. These two last calculi are usually found in debilitated, broken-down subjects.

Symptoms.—Renal calculus gives rise to pain in the loins of a dull aching character, often shooting down the thighs; to pain in the testicles, in the end of the penis, and to frequent micturition. Blood or gravel may appear in the urine, and from pyelitis being set up, pus is often present. The pain is aggravated by walking, running, &c., and attacks of renal colic are not infrequent; this is characterized by intense pain in the loins, shooting down to the thighs and testicles; the patient rolls about in agony, his face becomes pale and covered with a cold sweat, vomiting is frequent, and there is a constant desire to micturate, with the passage perhaps of only a few drops of bloody urine. Such attacks come on when a calculus of any size is passing down the ureter, and when it reaches the bladder relief is usually at once experienced.

Treatment.—In all cases where there is a tendency to the formation of stone—and this is often hereditary—great care should be taken as to diet and mode of life. If urine containing uric acid or urates is passed the diet should contain the minimum of nitrogenous matter, and the drink taken should be almost confined to pure water.

During attacks of renal colic, warm drinks and hot fomentations over the loins should be used freely, and opium, morphia, or chloroform inhalations given to check the pain. When it is clear that a calculus is lodged in the pelvis, and much disturbance is caused, the question of surgical treatment arises, and a few successful cases of nephrectomy for this condition have been lately reported.

Pyelitis (Pyonephrosis).—Pyelitis or inflammation of the mucous membrane of the pelvis of the kidney may arise from exposure to cold and wet, but more commonly is due to the presence of some local irritant, such as a stone, or parasite, or blood-clot, or it may be due to inflammation spreading along the ureter, or to some obstruction to the free escape of urine into the bladder. Where an abscess forms the condition is known as pyonephrosis.

Symptoms.—The chief signs of pyelitis are those of irritation of the kidney; pus is found in the urine, which is usually acid. If there is much inflammation there will probably be rigors, high temperature, and loss of strength. If an abscess forms, large quantities of pus may pass with the urine, and a tumour may form which may become so large as to simulate an ovarian cyst. The affected kidney may atrophy, the abscess may rupture into the peritoneal sac or externally, or it may dry up with atrophy of the kidney, leaving the other kidney to perform all the work of excretion.

Treatment.—Where the mischief can be traced to the presence of a calculus, that must be removed if possible; for other causes the main treatment is to improve the general health by tonics, and to check the discharge by astringents, such as alum, iron, and other mineral acids. For pyonephrosis surgical treatment must be adopted.

Perinephritic Abscess.—An abscess around the kidney is not uncommon; its usual causes are injury, exposure to cold and wet, or the extension of inflammation from the kidney or some other adjoining part.

Symptoms.—The abscess has a tendency to point externally, or it may open into the ureter, giving rise to much pus in the urine. There are the usual local and constitutional symptoms of abscess—viz., fever, rigors, and hectic, with a fluctuating tumour and œdema, and redness of the surface when the abscess approaches the skin.

Treatment.—The abscess should be encouraged to advance externally, and should be opened, kept well drained and clean. The patient's strength should be kept up with good food and pure air.

RARER RENAL DISEASES.

Tubercle of the Kidney sometimes occurs in tubercular subjects. This condition is difficult of diagnosis; there is wasting hectic, pus in the urine, which is deficient in quantity, and it is said that caseous matter is sometimes found in the urine.

Parasitic Growths.—The commonest of these is the hydatid tumour due to the same parasite which is found in the liver in hydatid disease. Externally a tumour may be felt, irregular or fluctuating, and if it bursts into the ureter renal colic may be set up, and traces of the parasite may be found in the urine. The Bilharzia hæmatobia is a nematoid worm, three or four lines long, which is found in the pelvis of the kidney. It gives rise to pyelitis, pyonephrosis, and causes death from hæmaturia.

Malignant Growths may occur in the kidney or elsewhere. Encephaloid cancer is not uncommon in young children.

Diabetes Mellitus.—Diabetes is not, strictly speaking, a disease of the kidneys. It seems to depend upon nervous disturbance, involving especially the arterial supply of the liver, and so disturbing its glycogenic function. Nothing, however, is known accurately of its pathology.

Causes.—In some cases it is hereditary, in others it appears to arise without any apparent cause. Injuries to nerves, cerebral and peripheral, is often accompanied by glycosuria, and diabetes often seems to be followed by complex cerebral disturbances.

Symptoms.—The most noticeable symptoms are the passing of large quantities of urine, light-coloured, of a high specific gravity, and containing more or less glucose or grape-sugar. Other symptoms are present, with more or less constancy, throughout the disease.

1. *Thirst and hunger* are excessive, the patient drinking enormous quantities of fluid, and showing unnatural appetite, often for the most indigestible articles of diet.

2. *Constipation* is usually obstinate, although occasionally intractable diarrhœa is present,

3. *The skin* is harsh and dry, and cannot be got to perspire. Boils and carbuncles frequently make their appearance, and are very troublesome.

4. *Eczema and irritation* of the vulva in women, and gleet in the urethra of men, is often present.

5. *Virile power* is nearly always diminished, and becomes lost as the disease progresses.

6. *The eyesight* frequently becomes affected, and the lens may become soft and opaque.

7. *Nervous symptoms* are common; there may be convulsive attacks, or complete insanity may set in.

8. *Emaciation* is progressive, and marked in all cases.

9. *Pulmonary phthisis* attacks and kills the majority of diabetic patients.

10. *Diabetic coma*, and death from asthenia, not uncommonly end the disease.

Diabetes runs a more rapid course in young than in elderly persons; and it should also be noted that sugar may be present in the urine to an appreciable amount, from some accidental cause, without diabetes mellitus being present.

The usual course of the disease is towards a fatal termination in from a few months to a few years.

Treatment.—The treatment in diabetes must be—1. Hygienic; 2. Dietetic; 3. Medicinal.

1. *Hygienic Treatment.*—The bowels should be regulated; the skin should be encouraged to act, and kept clean; warm clothing should be worn; fatigue avoided; and residence in a warm climate is advisable.

2. *Dietetic.*—Sugar, and sugar-forming foods, including all forms of starch, are to be avoided as much as possible, and results have been obtained from a purely skim-milk diet. Green vegetables, meat, fish, eggs, cheese and butter may be allowed. Instead of bread, gluten rolls and almond biscuits may be given. Glycerine has been given instead of sugar to sweeten articles of diet. Alcohol as a rule is hurtful. Drinks acidulated with dilute phosphoric acid may usually be given.

3. *Medicinal.*—Codeia, commencing with a grain or two a day, and increasing the dose gradually, decidedly checks the excretion of sugar. Opium is also largely given, and is very useful. Salicylate of soda, alkali, bromide of potassium, and iron, are among the other drugs which have been successfully used.

Diabetes Insipidus.—This disease is characterized by the

passing of large quantities of urine—often from twenty to forty pints or more in twenty-four hours—of a low specific gravity (1001 to 1004), free from sugar, albumen, or other morbid product. It may attack persons of any age or either sex, and is usually accompanied by many of the symptoms which go along with diabetes mellitus—such as thirst, voracious appetite, and a tendency to die from asthenia or from some rapid intercurrent disorder. It is sometimes associated with tuberculosis, with injuries to the nervous system, alcoholism, and is frequently hereditary, or found in persons who have a family history of diabetes mellitus. In other cases it is present with no great signs of derangement of health.

Treatment.—Valerian has been tried successfully in large and increasing doses, and the hygienic rules required for saccharine diabetes should be observed in cases of this disease.

HÆMATINURIA—HÆMOGLOBINURIA. — The presence of blood-colouring matter in the urine, sometimes giving the spectrum of hæmoglobin, without blood corpuscles or with only the detritus of corpuscles, is the most obvious character of this disease. The attacks are generally paroxysmal, the patient being well between the paroxysms. The first symptoms are rigors and fall of temperature; the extremities become cold and blue, and in some cases absolutely gangrenous, so that the tips of fingers, toes, nose, or ears may be destroyed. The urine passed is dark in colour, as if containing blood, but under the microscope no blood cells are visible. In a few hours the urine again becomes clear, the temperature becomes normal, and the patient regains his accustomed state.

The *causes* of hæmatinuria or hæmoglobinuria are very obscure. In some cases the condition seems to be dependent on loss of health from long-continued suppurative disease, or from ague, rheumatism, or some other exhausting complaint.

Treatment.—Good nourishment, warmth, tonics, and a warm climate are the only things which seem to be of service in warding off attacks.

HÆMATURIA.—Blood may be present in the urine from a variety of widely different causes. The following are the chief:—

1. Injuries to the urethra or some other part of the urinary tract.
2. Calculi in the kidney, ureter, bladder, or urethra.

3. Acute Bright's disease.

4. Congestion of the kidney from the use of cantharides, turpentine, &c.

5. In scurvy, purpura, and in phosphorus poisoning.

6. From the presence of the Bilharzia hæmatobia or other parasite.

7. From malignant or other tumours; especially from a villous growth in the bladder or pelvis of the kidney.

The diagnosis can usually be made by noticing the nature and amount of blood passed, and the circumstances under which it appears. When it comes from the kidney it is usually small in amount and intimately mixed with the urine; from the bladder, especially when due to a villous growth, it is generally large in amount, and the urine first passed is often quite clear; from the urethra the blood usually comes first, the urine at last being quite clear; when due to a calculus, it is usually accompanied by much pain and increased by movement.

Treatment.—The direct medicinal treatment consists in the administration of astringents, such as gallic acid, alum, acetate of lead, &c.; ergot is also useful, and the witch-hazel (*Hamameli virginica*) has been highly spoken of. Cold should be applied to the parts from which the blood comes, and the patient should be kept cool and in a recumbent position.

Bacilluria.—Dr. Roberts, of Manchester, has described a number of cases in which the freshly voided urine was found by him to be turbid from the presence of bacteria; in these cases the symptoms were those of ascites and irritation of the urinary passages with rigors and pyrexia. The urine voided was acid, had no undue tendency to decompose, and the bacteria did not multiply outside the body. Some of the cases seemed to be associated with rheumatism and rheumatic gout.

Treatment.—All Dr. Roberts's cases were treated successfully with salicylate of soda.

Chyluria.—In tropical countries, especially in China and India, the urine is sometimes found to be milky in appearance when passed, and liable to coagulate; the urine is then found to contain fibrin, albumen, white corpuscles, and fat in a molecular state as in chyle. The cause of the appearance of these substances in the urine has not been accurately determined, but the condition is associated with the presence of a microscopic parasite—the Filaria sanguinis hominis—in the urine and

blood. No specific for the disease is known. The parasite most likely gets into the body through drinking water, giving rise to grave disturbance of the nervous system, and it has been shown that the semilunar ganglia are also often affected along with the supra-renal capsules.

Treatment.—The progress of the disease is nearly always towards death, but improvement is sometimes noticed from careful hygienic treatment, change of air, rest, and the administration of iron and digitalis. Some cases of recovery under such treatment have been reported.

NERVOUS DISEASES.

In considering the effects produced by changes in the nervous tissues, it is well to bear in mind the main outlines of the structure and physiology of the central nervous system. It was first definitely proved by Charles Bell that the spinal nerves are mixed in function; the fibres from the anterior part of the cord being motor, those from the posterior part sensory. Besides their purely motor power over muscles, the nerves from the anterior region of the cord seem also to be greatly concerned in the *nutrition* of the tissues, as disease (not complete destruction, however) of these fibres, or their central cells in the grey matter of the cord, give rise to skin eruptions, atrophy of skin and muscles, destruction of joints, &c. Nerves also from the central motorial regions control the various secreting glands, as has been shown conclusively in the action of the chorda tympani fibres upon the submaxillary gland. The vaso-motor fibres also for the various blood-vessels travel by the same anterior cords. The sensory nerves also seem to contain different kinds of fibres; some conveying only impressions of general sensibility, some special sensations only, as touch, smell, sound, &c., and some sensations only of temperature. As there is no essential difference between cerebral and spinal nerves, they are here considered together. The white matter of the cord and brain is purely connecting in function, and consists of a continuation of nerve fibres differing from the nerve bundles running in the limbs and elsewhere only in minor anatomical points.

The fibres found in grey matter of the cord and brain differ from those in the white matter, in that the white substance of Schwann, which forms an insulating sheath

round the axis-cylinders, is absent. It contains, besides abundance of axis-cylinders, an immense number of large protoplasmic cells, which are the terminations of axis-cylinders from the motor or sensory nerves; these masses of protoplasm are also connected intimately with one another. A slight examination of a transverse section of the cord shows us *that these cells are arranged in groups*, and that they are larger and more numerous in the anterior part of the grey matter than behind. If we follow the cord into the skull we find that at its upper part it opens out like a book, so that the floor of the fourth ventricle unfolds the grey matter which is found elsewhere closed up and surrounded by white fibres. Still following it on, we find it passing through the pons Varolii (giving a large band of fibres to the overhanging cerebellum), then having a pair of elevations on each side on its upper surface—the corpora quadrigemina or optic lobes—it divides bilaterally. The lower part, corresponding with the anterior part of the cord, goes to the corpus striatum of its own side, the upper part, corresponding with the posterior part of the cord, goes to the optic thalamus. Overhanging these basal ganglia, as they are called, is the cerebrum with its many convolutions and its great bulk. It is composed of an outer cortex of grey matter and an inner layer of white fibres, and is intimately connected with the subjacent structures; the different parts of the cerebrum and the two halves are also connected with each other by commissural fibres.

Briefly the functions of these various parts may be thus stated:—

1. The groups of ganglion cells in the anterior part of the cord are each connected with and govern the motions of certain groups of muscles; while in their turn these cells are connected with and governed (the impulses passing by way of the corpus striatum) by cells in the cerebrum. The advantage of this arrangement is that a single nerve fibre passing from the brain may thus be able to set in motion a dozen or more muscles if need be.

2. The ganglion cells in the posterior part of the cord collect information from the periphery, transmit this information (by way of the optic thalamus) to the cerebrum, which uses it in directing the action of the muscles.

3. Communication between the brain and the cord goes

on chiefly by means of the fibres in the lateral columns of the cord; the anterior and posterior columns being chiefly engaged in transmitting impulses *to* muscles, and *from* the various sense organs to the central grey matter.

4. Each part of the cord usually governs that part of the body which is nearest to it; but in the medulla oblongata are collected the central cells (or, better, intermediary cells), which govern the heart, the circulation, respiratory movements, and other important functions upon which the general welfare of the body depends.

5. The functions of the cerebellum seem to be to harmonize or co-ordinate the movements of the body when a number of complex combinations are necessary.

6. The corpora quadrigemina govern the movements of the eyes.

7. The optic thalami are the centres towards which all the sensory nerves of the body converge, prior to transmitting their impulses to the cerebrum.

8. The corpora striata receive from the cerebrum all impulses destined for the motor nerves.

9. The cerebrum in its anterior part is chiefly the seat of volitional impulses; there is abundant evidence that different parts govern distinct areas of the body. In its posterior part it receives and retains sensations from without.

Surrounding all parts of the brain and cord is a delicate vascular membrane, the *pia mater*, which supplies blood to the grey and white matter; outside this there is the *arachnoid*, a serous membrane like the peritoneum, containing the cerebro-spinal fluid, and next to the bones is the thick fibrous *dura mater*. In addition it is to be borne in mind that both motor and sensory nerves change sides in passing from the brain to the periphery. The sensory fibres cross over soon after they enter the cord; the motor cross over soon after they leave the corpus striatum, but chiefly at the anterior part of the apex of the medulla oblongata. It thus happens that the right side of the brain governs the left side of the body, and the left side of the brain the right side of the body.

It will be convenient to consider diseases of the nervous system in the following order:—

1. Diseases of the brain and its membranes.
2. Diseases of the cord and its membranes.
3. Nervous diseases having no regular lesions.

DISEASES OF THE BRAIN AND ITS MEMBRANES.

Affections of the Dura Mater.—The dura mater is frequently the seat of hæmorrhage, due to injury, or of inflammation, chronic or acute, following injuries or occasioned by absorption of pus from neighbouring parts, as in cases of purulent otitis. According to the amount, seat and nature of the effusion, the symptoms may be those of excitement, delirium, convulsions, or coma. Intense headache, when the patient is sensible, is always a noticeable symptom.

Gummata, from syphilis, may attack the dura mater, and by pressure on nerves at their exit from the brain may give rise to various forms of paralysis; or by pressure on the brain itself may give rise to convulsions, epileptiform in nature. Cancer may also attack this membrane, either primarily, or more commonly following malignant disease in adjacent structures.

Treatment.—The treatment of these affections must depend on the cause. Where the inflammation is due to violence, as in the case of a depressed fracture of the skull, trephining may have to be performed. If there is a syphilitic history, iodide of potassium or mercury should be given. In acute inflammation the patient should be kept as much at rest as possible; ice should be applied to the head, or blisters may be applied to the nape of the neck. The bowels should be freely opened.

Meningitis.—Inflammation of the meninges or immediate coverings of the brain may be due to a variety of causes. The most important are the presence of tubercle in the pia mater, injuries, local irritation from new growths, excessive mental labour, and erysipelas.

Tubercular Meningitis or Acute Hydrocephalus is usually met with in children, but may occur at any age.

Causes.—It may be part of general tuberculosis, or may result from the presence in some part of the body of inflammatory products undergoing caseous degeneration, and by infection setting up tubercular deposits. Anything which depresses the general health may be a predisposing cause; a phthisical family history is found in the majority of cases. Post-mortem, minute tubercles are found in the peri-vascular lymphatic sheaths of the smaller arteries and capillaries of the pia mater. These

may be distinctly visible to the naked eye, or so small as to require microscopical examination before they can be demonstrated. They are usually found most abundantly about the fissures of Sylvius at the base of the brain, or they may be general, or only found at the convexity of the cerebrum. There is often considerable effusion into the ventricles, and the brain substance is usually sticky from the presence of puriform lymph.

Symptoms.—Usually the acute stage of this disease is preceded by a period when nothing may be noticed beyond a little dulness of intellect, drowsiness, and disinclination for food or exertion of any kind. The head seems to be heavy, and the patient's sleep is restless and disturbed. There is usually obstinate constipation. Day after day passes, with no improvement. Gradually the symptoms become more marked. There is intense headache, delirium, and staggering gait. The patient cannot bear the least noise or light. Food is immediately rejected, and vomiting persists even when the stomach is emptied. The bowels remain constipated, the tongue is furred, the pulse quickened, and the temperature may reach 100° to 102°, but is never very high. As the disease advances stupor becomes more marked, there is frequently a plaintive cry uttered, and convulsions come on. The pupils are dilated, there may be strabismus, and if the patient lives for some time ulceration of the cornea may come on. Frequently there are remissions, which falsely raise hopes in the minds of the friends; but these soon pass away, and death occurs sooner or later. In the later stages of the disease there is often diarrhœa, the pulse becomes slow and irregular, and the temperature falls. There is no curative treatment for this disease which, when it has once declared itself, is fatal. It is sometimes important to diagnose the convulsions occurring in healthy children from hyperæmia of the brain from the convulsions of tubercular meningitis. This can usually be done by the history, which almost invariably in the latter case shows a preceding period of ill-health and a tubercular tendency, which are absent in the former.

Simple Meningitis.—The course of simple acute meningitis is generally divided into three distinct stages.

1. There is a stage of excitement in which delusions of the senses are frequent, and delirium may be violent. Cerebral vomiting—that is, acts of vomiting not occasioned by taking food, or ceasing when the stomach is

emptied—is always present. The temperature is high and the pulse rapid. Convulsions, general or partial, occur, and there is great intolerance of light or sound, and intense headache.

Second Stage—Failure of Cerebral Functions.—The patient becomes heavy and drowsy, he is with difficulty roused, the pulse becomes less frequent, the skin cools, and, as in typhus fever, there is twitching of the hands, subsultus tendinum, and low muttering delirium.

Third Stage—Collapse.—The symptoms of the second stage become intensified, and the patient has the aspect of one in the worst form of typhus. The teeth become covered with sordes, the tongue is dry and brown, the bladder becomes distended, and urine and fæces are passed unconsciously. The pulse is feeble, rapid, and irregular.

These symptoms are generally preceded, as in tubercular meningitis, by a variable period of ill-health, when headache, local or general, is complained of. There is also usually much irritability, and there may be epileptiform convulsions and sickness.

Hyperæmia of the Brain.—Hyperæmia of the brain, as of other parts of the body, may be either active or passive. Active hyperæmia is that condition where there is an excessive amount of blood driven to the brain, and is therefore an arterial congestion. Passive hyperæmia is due to some obstruction to the free exit of blood from the brain, and therefore a venous congestion.

Causes of arterial or active hyperæmia :—

1. Excessive action of the heart.
2. Diminished resistance in the blood-vessels.
3. Obstruction in other parts of the arterial circulation, as from compression of arteries, excessive cold contracting the capillaries of the skin, &c.
4. Excessive plethora, from eating and drinking too much.
5. Atrophy of the brain (as in chronic alcoholism).

Causes of passive or venous hyperæmia :—

1. Compression of the great veins of the head and neck.
2. Energetic expiratory efforts, as in coughing, playing on wind instruments, &c.
3. Incompetence of the valves of the heart, and dilatation of the right side.
4. Diseases of the lungs, whereby the free passage of the blood through them is impeded.

Symptoms of Hyperæmia.—In slight hyperæmia of the brain, brought on by over-excitement, mental or bodily, the face is flushed, there may be headache and vertigo, and there may be much sensory irritation. In young children convulsions are a constant accompaniment of this condition; these convulsions do not usually last for more than half an hour, but may go on for a much longer time. In severer cases, in adults, there may be epileptiform or apoplectiform attacks. In other cases there may be maniacal attacks. When these occur in the course of a heavy drinking bout, they may resemble an attack of delirium tremens. Sometimes there may be mania of a melancholic form, resembling insanity. Sleeplessness is a constant and distressing symptom. In cases where the hyperæmia is congestive or venous, the symptoms are also varied, and resemble those found in anæmia.

Treatment.—It is very important to try to discover the cause of the condition, and remove or modify it. Active purgatives such as croton oil, or enemata, are of much use. If there is stoppage of the menses, the regular flow should be established if possible, and leeching the thighs and cervix uteri is useful. Ice to the head, foot-baths, blisters to the nape of the neck, are all useful remedies. Individuals subject to such attacks should be carefully dieted, and regular exercise should be enjoined.

ANÆMIA OF THE BRAIN.—*Causes.*—1. Loss of blood from hæmorrhages, wasting diseases, &c.

2. Obstruction of the arteries supplying the brain.

3. A rush of blood to other parts, as in dry cupping, hot foot or hip bath.

4. From deficient action of the heart, as in mitral or aortic incompetence.

5. General anæmia, Bright's disease, &c., where blood of an inferior quality is supplied to the brain.

Symptoms.—Patients suffering with general anæmia nearly always suffer from disturbances of the central nervous apparatus. They become giddy or faint on slight exertion. In some cases there may be sleeplessness or delirium (as in cases of starvation); in children, especially, there may be convulsions. It is frequently a difficult matter to distinguish the symptoms of anæmia from those of hyperæmia of the brain. This may be partly due to the fact that in many cases of hyperæmia there is really capillary anæmia from œdema, and consequent pressure on the smaller vessels.

Treatment.—If the patient is reduced in health it is important to remedy this condition by good food and tonics. In all cases the sitting or lying position should be enjoined during attacks of giddiness or fainting. Stimulants may be necessary if the heart's action is much enfeebled.

Chronic Hydrocephalus (Water on the Brain).—Chronic hydrocephalus is a disease exclusively of childhood; rarely it is found in adult life. Dr. West (agreeing with Rokitansky and Vrolik) believes that in the majority of cases it is due to a chronic inflammation of the arachnoid, and occasionally to the pressure of some tumour on the lateral sinuses or venæ Galenæ, giving rise to a passive dropsy. The fluid of hydrocephalus may be found in the ventricles (internal hydrocephalus), or in the sac of the arachnoid (external hydrocephalus), or in both. The first condition is the most common. The patients are usually rickety. In many cases the disease commences while the fœtus is in the uterus, and may be even an obstruction to its delivery.

Symptoms.—The early symptoms are those of malnutrition, and convulsions are frequent and often fatal. Diarrhœa is often present, and the debilitated condition of the patient renders him peculiarly liable to be carried off by this or some other intercurrent disorder. The aspect is characteristic. As the fluid within the skull increases the bones of the head are pushed out of their normal position. The forehead is prominent; the orbital plates of the frontal bone are pushed downwards obliquely, making the eyes prominent, and giving them a downward direction. The anterior fontanelle is prominent and widely open, and fluctuation may be felt there. The veins on the scalp are distended, and the growth of hair is scanty.

Most cases of hydrocephalus have remissions, and sometimes there may be actual arrest of the disease; but the prognosis must always be somewhat gloomy.

Treatment.—This must be directed to the improvement of the general health, and to the checking of diarrhœa. Dr. West recommends the administration of salines, diuretics, and small doses of bichloride of mercury, with cold or tepid applications to the head when the symptoms are pressing; when the state is one of cachexia chiefly, he gives iodide of potassium or iodide of iron, with cod-liver oil. Compression of the skull by

elastic bandages or strapping, and tapping through the anterior fontanelle, have also been useful in some cases, but are methods of treatment which may lead to sudden death.

Hydrocephaloid Disease.—Hydrocephaloid disease is a condition first called attention to by Dr. Marshall Hall. It is found in young children who are the subjects of some rapidly exhausting disease, the most common condition being infantile diarrhœa. Dr. Hall divides the symptoms into two stages:—1st. That of irritability, in which the infant is irritable, restless, and feverish; the bowels are flatulent and loose, and vomiting is urgent and persistent. 2nd. That of torpor, in which the patient becomes exhausted, the face is pale and cold, the breathing is irregular, the eyes are closed, and the pupils are unmoved by light.

Treatment.—The diarrhœa must be checked by Dover's powder or enemata, and means used to stimulate the flagging powers. The warm bath is very useful, and small quantities of barley-water or beef-tea, given cold, may be administered. As this condition may come on in the course of any exhausting disease or in premature weaning, its symptoms should be carefully looked for, as the earlier supporting treatment is adopted the greater is the likelihood of success in treating it.

Hypertrophy of the Brain.—The majority of cases of hypertrophy of the brain seems to occur in infants of from six to eight months old. It is generally associated with rickets and general mal-nutrition. The condition is due to an albuminoid infiltration of the cerebral substance, not to increase in the nervous matter, and does not affect the basal ganglia.

Symptoms.—Without any definite illness the child becomes dull and apathetic, loses its appetite, and sweats profusely about the head. There is headache, and as the child grows older there may be observed deficiency of intellect, in some cases amounting to idiocy, although in other cases the child may remain fairly intelligent. The head hangs heavily as if it were a burden to its owner, and has a superficial resemblance to the head in hydrocephalus. The fontanelles are wide open but are not tense, the projection is more in the occipital than in the frontal region, and the eyes are not pushed downward as in the latter disease.

Treatment.—The head should be supported by some

kind of pad and cushion, and should be protected by a light linen cap: cod-liver oil and the iodide of iron may be given. The diet should be especially attended to. Frequent sponging with salt or sea water, or bathing in tan water (made with a decoction of oak bark) is recommended by Dr. West.

APOPLEXY.

There is some confusion in the use of the term apoplexy. Taken literally, it describes symptoms common to many conditions. It means stricken or disabled by a stroke in mind or body, or both; and while some physicians give it a very wide range of application, others restrict it (as Trousseau) to those cases only in which there is sudden and complete loss of consciousness. It will be convenient to consider the different causes of apoplexy, using the term in its widest sense, separately.

Meningeal and Cerebral Hæmorrhage (Sanguineous Apoplexy).—Excluding injuries to the skull, the commonest causes of meningeal hæmorrhage are rupture of aneurisms (especially at the base of the brain), rupture of degenerated arteries, breaking through of cerebral hæmorrhages, and probably acute alcoholic poisoning in an alcoholic subject. Old age, insanity, and drunkenness are predisposing causes.

Cerebral hæmorrhage, like meningeal, occurs in connection with degeneration of arteries, and is therefore most common in advanced life. There may be atheromatous degeneration or aneurism of minute vessels, due to atheroma or fatty change. Atrophy of the brain, frequent in old age, is also a predisposing cause of hæmorrhage, as it gives rise to dilatation of vessels and lessens their support. Hypertrophy of the left ventricle of the heart, when it is associated with arterial degeneration, is also an important factor in determining hæmorrhage.

The two opposite conditions of heavy feeding and starvation are favourable to the occurrence of hæmorrhages, the one by over-filling the vessels, the other by inducing fragility.

Plugging of small arteries, either by an embolus or thrombus, often leads to capillary extravasations.

The exciting causes of cerebral hæmorrhage are excessive cardiac action, checking the return of blood from the brain, excessive mental exertion, and plethora from much eating or drinking; often attacks come on, as when

the patient is in bed, without apparent exciting causes. A remark of Niemeyer's is worth bearing in mind, as it is abundantly borne out by experience: "There is no such thing as an apoplectic constitution indicated by a short neck and broad shoulders."

Symptoms.—Apoplexy may come on suddenly, or may be preceded by severe headache, sensory disturbances, temporary loss of speech, &c. The symptoms vary according to the seat and extent of the bleeding. By far the greatest number of cases are due to hæmorrhage from a branch of the middle cerebral artery of the left side, sometimes called the artery of cerebral hæmorrhage, and the parts most commonly affected are the left corpus striatum and optic thalamus. In a typical case, with or without premonitory symptoms, the patient becomes unconscious. The head is usually turned to one side, breathing is slow and stertorous, the pulse is slow and full, the carotids pulsate visibly (a sign of some obstruction to the flow of blood through the brain, as Niemeyer points out, not of increase of supply), the face is flushed or pale, the pupils are insensible to light and touch, and often dilated. At first the temperature may be lower than normal. Fæces and urine may be passed involuntarily. In the early stages paralysis of one side of the face may be observed, but this may not be evident until consciousness returns. After a time, varying from a few minutes to a day or two, the patient becomes conscious, and he then finds he is unable to move one side of his body, usually the right, and that he is partly devoid of sensation on that side. The face may be paralyzed on the same or opposite side to the body. He is unable to speak, or speaks indistinctly. The temperature now rises above normal, and there is headache with other symptoms of cerebral disturbance. This usually passes off in a few days, but occasionally there is an acute inflammation of the brain which may prove fatal. The paralysis of the muscles is permanent, although there may be slight improvement in some of them. If the hæmorrhage is very abundant the medulla may be pressed on, and death then comes on without any return to consciousness; while, if small, there may be nothing beyond a slight feeling of dizziness along with the hemiplegia.

Slight hæmorrhage into the *body of the hemispheres* may be unaccompanied by symptoms of paralysis.

Meningeal or Cortical Hæmorrhage is generally ushered in by convulsions, and followed by meningitis. Hæmorrhage into the *pons Varolii*, produces profound unconsciousness, contraction of the pupils, and internal squint.

Cerebellar Hæmorrhage may occur without either loss of consciousness or paralysis; violent vomiting and pain at the back of the head are said to be among the symptoms, which are however very indefinite.

Hæmorrhage into *the medulla* is very rapidly fatal.

Cerebral Embolism and Thrombosis, and their Results.—By embolism is meant the blocking-up of a blood-vessel by a foreign body (an embolus) carried from some distant point in the circulation: by thrombosis is meant the blocking-up of a vessel by the formation of a coagulum (a thrombus) in the affected part.

The chief causes of cerebral embolism are, the detachment of fibrinous growths from diseased valves of the heart, the separation of portions of a thrombus in cases of aneurism or of pulmonary thrombosis, and the separation of dead tissue in cases of ulcerative endocarditis and endarteritis. Cerebral thrombosis usually arises from degeneration of the walls of the small arteries of the brain, and is almost exclusively a senile change.

Thrombosis and embolism both occur most frequently in connection with the left middle cerebral artery and its branches. As a result of these conditions the part of the brain which ought to be supplied by the occluded vessels undergo various changes. At first there is simple anæmia; this is followed by fatty degeneration, or if the embolus sets up inflammation, an abscess may form.

The degeneration of the brain most commonly produced is known as *cerebral softening*; this may be white, yellow, or red.

White softening is often a slow change resulting from senile degeneration, interfering with the calibre and contractility of the smaller cerebral arteries, and from diminished action of the heart. It is sometimes acute, from an embolus plugging one of the larger cerebral vessels.

Yellow softening may be a variety of white softening in which a yellow colour is given to the degenerated tissue from the close aggregation of freely divided fat globules, or the colour may be due to the presence of altered blood pigment from old extravasation.

Red softening may be due to encephalitis, to embolism, or to thrombosis with capillary hyperæmia and extravasa-

tion. It is an acute form. The primary change in these various forms of softening is a fatty degeneration of the proteid matter of the nerves, ganglion cells, and connective tissue (neuroglia) of the brain. The area of softening shades gradually into the healthy tissue, and is detected by its softness and the ease with which it is broken down when a stream of water is gently poured over it.

Symptoms.—An embolus blocking a large artery of the brain gives rise to sudden loss of consciousness, with paralysis of the opposite side of the body. If the vessel affected is a small one, there may be only at first partial paralysis, with some aphasia, while the mind is little if at all affected. These cases are often difficult to diagnose from sanguineous apoplexy. Embolism is, however, always associated with heart, lung, or arterial disease, and may occur at any age, while hæmorrhage is rarely found in the young.

Thrombosis is found in old persons, and there are usually well-marked premonitory symptoms; these consist of headache, giddiness, failure of memory, loss of speech or confusion of words, with occasional transient paralysis of the body or limbs. When an extensive thrombus forms, the symptoms are those of hæmorrhagic apoplexy, from which it may not be possible to diagnose it.

Frequently the changes are altogether chronic, and the slow softening is then marked by mental weakness or imbecility, which may go on for a considerable time before death ensues from hæmorrhage, or coma from gradual destruction of cerebral tissue.

Treatment.—Obviously no curative treatment exists for any of these conditions. The most that can be done is to keep the patient at rest, avoid depletory measures, and give nourishment in a fluid and digestible form.

Tumours of the Brain.—The most common tumours of the brain are syphilitic growths, tubercle, cancer, sarcoma (glioma), myxoma, parasitic cysts, blood cysts, congenital cysts, containing hair, &c., and aneurism. The causes of origin of these growths is in most cases obscure; some of them are due to general constitutional infection or predisposition, as in the case of tubercle and syphilis, and there is frequently a history of injury to the head antecedent to the symptoms of tumour.

Symptoms.—These vary much both in kind and in order of appearance. Constant severe headache is one of the most invariable symptoms. If the basal ganglia are

affected there may be complete hemiplegia. If the body of a cerebral hemisphere is alone affected and the growth is slow, there may be hardly any symptoms at all. If the cerebral nerves are implicated, various local paralyses ensue. Tumours in the cerebellum are usually marked by constant pain at the back of the head, and incoördination of muscles. Cerebral vomiting is a frequent symptom. In tumours originating in or pressing on the cortex of the cerebrum there may be epileptiform convulsions, either with or without loss of consciousness. There is often much wasting of the body, and death nearly always occurs sooner or later, either gradually or suddenly, after an apoplectic attack.

Treatment.—If there is any reason to suspect syphilis, iodide of potassium should be given, or other anti-syphilitic treatment should be adopted. This is the only condition admitting of curative measures. If these fail we must confine ourselves to relieving the symptoms as they arise. Sedatives may be given or counter-irritation used to alleviate the pain, and the general health should be attended to by nutrient diet and regularity of life.

DISEASES OF THE SPINAL CORD AND ITS MEMBRANES.

Spinal Meningitis.—The chief causes of spinal meningitis are injuries, extension of inflammation as in vertebral caries or bed sores, new growths, and exposure to cold or wet.

Symptoms.—Severe pain in the back, increased by pressure or movement, is an early and well-marked symptom. If the meningitis is acute there will be rise of temperature, and sometimes well-marked rigors. Symptoms due to irritation of the nerve trunks next become prominent. Pain, referred to the peripheral ends of the nerves and spasms of muscles, varying according to the extent of the disease, from occasional starting to severe tetanic convulsions, may be observed. Paralysis of the bladder, rectum, or paraplegia, may also come on. Exacerbations and remissions of symptoms always occur. The most important diagnostic points in spinal meningitis, whereby it is distinguished from primary myelitis, are, *signs of irritation*, the *exacerbations* and *remissions*, and generally the fact that the disease *spreads from below upwards, both as regards*

the sensory and motor phenomena. The prognosis is always grave.

Treatment.—Energetic counter-irritation is the treatment which offers the best chance of success. Leeches may be applied over the regions of most tenderness. In traumatic cases cold should be applied, and in chronic cases flying blisters are serviceable.

Epidemic Cerebro-spinal Meningitis.—The causes of this form of meningitis are not well known. It appears under the same circumstances which are favourable to the appearance of typhus—viz., overcrowding and bad hygienic conditions; but, unlike typhus and the acute specific diseases generally, there is no evidence that it is contagious. Children and young persons are most frequently attacked, and it often occurs in people of middle age, whilst old people are but rarely affected.

Symptoms.—Rarely there is premonitory headache, but usually the onset of the disease is marked by a sudden chill. Severe headache, restlessness, and contraction of the pupil, the mind remaining clear, then come on. Cerebral vomiting is generally present. The temperature rises, the pulse becomes quickened to 80 or 100. By the end of the first, or on the second, day the head is drawn back, and herpetic eruptions appear near the mouth and other parts of the face, and sometimes in the extremities. By the third day the mind is usually confused, or consciousness is lost. There are tetanic convulsions of the muscles and opisthotonos; there is loss of power over the bladder, and complete constipation. Death may now come on, preceded by complete coma.

In severe cases death may ensue in a few hours. In other cases the symptoms are of less intensity, and recovery takes place; while in still another set of cases the symptoms may present a well-marked intermittent type. As in ordinary meningitis, the sensory disturbance may be marked by a period of extreme hyperæsthesia, followed more or less by complete anæsthesia. The rate of mortality is very high; a temperature above 103°, purpuric spots on the skin, purulent deposits in joints or in the eyeball, are all signs of a fatal form of the disease.

Treatment.—The local application of cold over the nape of the neck and spine should be adopted early and persevered in. Hypodermic injection of morphia, opium, and chloral by the mouth, and calomel, are the remedies

that are generally used. The patient's strength must be kept up as in fever of the typhoid type; the bladder should be emptied with a catheter if necessary, and the bowels relieved by enemata.

Hæmorrhage of the Cord and Membrane—Hyperæmia of the Cord.—Hæmorrhage and hyperæmia are both affections which seem to be of very rare occurrence, and which are difficult of diagnosis. The intense pain in the back which is characteristic of the invasion of small-pox, and sometimes of typhoid fever, is due to spinal irritation, probably from hyperæmia. Small extravasation may occur under the same circumstances, and injuries to the back may produce larger hæmorrhages. The symptoms will depend upon the extent and seat of injury, and may vary from complete and fatal paralysis from implication of the phrenic nerves and other nerves of respiration, to slight disturbance of sensation or movement or nutrition.

Treatment.—Rest is the treatment chiefly called for, but counter-irritation may be applied over the supposed seat of injury. Special care should be taken to prevent the occurrence of bed sores, and the accumulation of urine in the bladder or fæces in the intestine should be prevented.

Chronic Inflammation of the Nervous Centres—Sclerosis.—Chronic inflammation may attack any part of the cord or brain. The naked-eye appearances of inflamed spots or patches show a tissue harder than normal, grey in colour at first, but becoming rosy red after exposure to the air, and well supplied with blood-vessels. These patches may be found in the centre of the cerebrum or cerebellum, but rarely in the cortex and in any part of the basal ganglia or cord. They are usually irregularly disseminated, and on this account and because of their hardness this condition is spoken of as disseminated or insular sclerosis. But the same kind of change may occur in larger tracts, or limited to certain distinct areas. Microscopically, these sclerosed patches are seen to consist of hypertrophied connective tissue (neuroglia); in the earlier stages many fatty granules can be seen from the breaking down of the nerve sheaths, but later on these and the axis-cylinders disappear. In the grey matter a similar appearance is presented, and atrophy and disappearance of nerve ganglia ensue. Sclerosis may extend into the nerves leading from or to the cord or brain.

Very little is known as to the causes of disseminated

sclerosis. It is a disease of early adult life, and, according to Charcot, is more common among women than among men. Hereditary predisposition has not been shown to have much influence. Cold, exposure to damp and cold together, mental or moral shock, and the acute specific fevers, such as small-pox and typhoid fever, have been shown to have played a part in producing disseminated sclerosis in some cases.

Sclerosis affecting large tracts (fasciculated sclerosis) is often the result of hæmorrhage or softening, but frequently no cause can be assigned for it.

Disseminated Sclerosis—Insular Sclerosis.—According to the seat of the disease this affection has been divided into three classes:—

1. The spinal form.
2. The cerebral form.
3. The cerebro-spinal form.

Symptoms of Cerebro-spinal Sclerosis—Head Symptoms.—Disorders of vision, speech and intellect are frequently prominent. There may be double vision (diplopia); this is usually only transient. Dimness of vision is very commonly a persistent and prominent symptom, not accompanied by any well-marked ophthalmoscopic changes. A more noticeable symptom (met with in about half the cases of cerebro-spinal sclerosis) is oscillation of the eyeballs (nystagmus). Sometimes this symptom is constant; in other cases it is only met with when the eyes are directed to any special object.

A still more constant symptom is a difficulty in enunciation, making the speech slow, drawling and thick, as in partial intoxication. The term "scanning" has been applied to this peculiarity of pronunciation; the consonants *l*, *p*, and *g* are usually badly pronounced.

Vertigo is a frequent symptom, and in some cases there may be hallucinations or melancholia. Where the medulla oblongata is attacked disorders of deglutition, circulation, or respiration may arise, which are always ominous of a fatal ending of the case.

Limb Symptoms.—Generally the lower limbs are first affected, but the disease may first show itself in the upper extremities. The disturbances are usually altogether motor. The patient finds at first that one or both legs feel heavy, and are moved with difficulty. On putting the muscles in motion there is much tremor. When the upper extremities are affected the same phenomena occur.

It is noticed that in setting certain muscles in motion to do a certain thing, the object is attained, but with much irregularity of movement. Thus, if a glass of water is to be carried to the mouth, all the necessary movements are performed, but with so much oscillation as to spill, perhaps, most of the contents of the tumbler.

Very prominent symptoms can be detected in the early stages of the disease, and later by tapping gently on the tendon uniting the patella to the front of the tibia when the leg is slightly flexed. There is then an exaggerated action of the extensor muscles of the thigh, causing the leg to be straightened quickly and forcibly. This test is generally spoken of as the "patellar reflex," or "knee-jerk." Similar "reflex" effects are produced at the ankle-joint, and in other situations by like means. In the course of the disease apoplectiform and epileptiform attacks may occur. No lesion has ever been found to account for these, and it is important to note that when the apoplexy or epilepsy is due to sclerosis, there is always a rise of temperature (100° to 104°, or higher) during the attack; whereas, in true apoplexy the rule is to find the temperature subnormal it may be twenty-four hours after the attack.

Charcot divides the history of cerebro-spinal sclerosis into three periods. In the first period the symptoms are generally only spinal, but head troubles may also be present. The characteristic tremors may be present, or there may be only vague symptoms of loss of muscular power. This period embraces a number of years. In the second period the tremor becomes more marked, and contraction of the limbs sets in, until the patient becomes completely bedridden. In the third period nutrition becomes affected. Diarrhœa is frequent, and general emaciation sets in. Bed sores are now likely to form; the sphincters act imperfectly, the intellect becomes clouded, speech and swallowing become difficult, and, finally, death ensues.

Treatment.—No treatment has been found to have much influence on the course of this disease. The most that can be done is to try to improve the general health, and in the later stages of the disease to endeavour to prevent bed sores, and to alleviate other local troubles as much as possible.

Lateral Sclerosis.—In this disease there is found a symmetrical and primary sclerosis of the lateral white columns of the spinal cord. The grey matter of the

anterior cornua may be secondarily affected. Lateral sclerosis is sometimes found also to be secondary to cerebral lesions, involving some part of the motor tract.

The distinctive features of this disorder, as given by Charcot, are—

1. It has a comparatively rapid course, proving fatal in from one to three years.

2. The limbs are paralyzed successively, atrophy following the paralysis, and death is caused by affection of the medullary centres.

3. Women are more often affected than men, and it may appear at all ages, varying from twenty-six years to fifty years.

4. Exposure to cold and damp and injuries are the chief assigned causes.

The paralysis usually first attacks the arms, and the disease is not ushered in by any fever. Sometimes there is tingling, and, as a rule, there is faint numbness of the affected limbs. In the early stages of the disease there is much rigidity of the affected muscles, and this is followed by permanent spasmodic contraction, often leading to much deformity. Where movement remains to any extent, it is always accompanied by the same kind of tremor that we find in disseminated sclerosis. When paraplegia comes on, it is not accompanied by any paralysis of the sphincters or tendency to bed sores.

Treatment.—The constant or interrupted current may be used, but the progress of the disease is usually sure and fatal.

Infantile Paralysis and Adult Spinal Paralysis.—These two affections may be considered together, as their history and anatomical lesions present the same characters. Infantile paralysis usually attacks children between the ages of one to three years. Its invasion is abrupt, being almost invariably marked by fever, with or without convulsions or other cerebral symptoms. As soon as attention is directed to the limbs, more or less motor paralysis is found to be present. Both legs, or one, may be affected; rarely one or both arms only may be paralyzed, or there may be complete paralysis of the whole body. There is no loss of sensibility, or affection of the bladder or rectum. Pain seems to be usually present, but in children this symptom is not always easy to observe. In adults the invasion period presents the same characters, accompanied by decided

pain or creeping sensations. With the Faradaic current the affected muscles show no reaction.

The febrile symptoms soon subside, and the paralysis usually partially disappears. Those muscles in which it persists atrophy, the paralyzed limb becomes colder than its fellow, and the bones of the limb cease to grow. If the muscles persistently present no reaction to the Faradaic current for eight or ten months, the paralysis is usually permanent. The lesion in both infantile and adult paralysis in these cases has been shown to be in the anterior cornua of the spinal cord. It consists, primarily, of disease of the large motor ganglionic cells in that region; secondarily, there is sclerosis of the surrounding tissue and of the adjacent antero-lateral columns. The nerve cells have been found hypertrophied, pigmented, atrophied, and in old-standing cases entire areas have been replaced by sclerosed tissue.

Treatment.—The affected muscles should be regularly treated with the constant or interrupted current. Shampooing the limbs is sometimes useful, and care should be taken to keep the parts warm and clean. The general health should of course be carefully attended to, but no drugs have been found to be of service in these cases.

PROGRESSIVE MUSCULAR ATROPHY (WASTING PALSY).—This is a form of disease which contrasts strikingly with ordinary paralysis, but which is due to a lesion similar to that which we find in infantile paralysis—viz., sclerosis of nerve centres.

The characteristic symptom is atrophy of muscles, accompanied by enfeeblement of movements, culminating in paralysis only when the muscular wasting is far advanced. The disease may show itself in childhood, or more commonly in adult life. It commences most commonly in the muscles of the ball of the right thumb; these atrophy and (as do all the other affected muscles) present curious fibrillar twitchings. The muscles of the hypothenar eminence and the interossei then are affected, and as these latter atrophy the hand assumes a claw-like form. From the hand the disorder spreads to the forearm and arm, picking out muscles somewhat irregularly; the triceps is commonly left untouched. From the limb the disease spreads to the muscles of the trunk, and death may ensue from affection of the muscles of respiration and deglutition. Rarely the lower limbs are first

affected. Sometimes the trunk muscles are the first to be attacked, and it has been noticed that in children the disease may first show itself in the muscles of facial expression, giving a blank idiotic expression to the patient. Usually the cause of the disease is slow, unless when it primarily attacks the muscles of the trunk or of swallowing; it may extend its course over eight to ten or twenty years. The lesions found after death show that the disease is due to a chronic inflammation of the cells in the anterior cornua of the grey matter of the cord.

Charcot describes the varieties of progressive atrophy. One he calls protopathic or primary, and this form he believes commences in the motor cells, which may become changed as in infantile paralysis; these changes lead to atrophy of motor nerves and muscles. The second variety he calls deuteropathic, or secondary. The mischief here is also in the motor cells, but follows meningitis, sclerosis of the posterior columns, central myelitis, tumours of sarcomatous nature, disseminated sclerosis of the white matter, or fasciculated sclerosis.

Treatment.—Systematic use of the constant or interrupted current seems occasionally to avert the wasting. No other treatment has been found to have any effect on the course of the disease.

Progressive Locomotor Ataxy (Tabes Dorsalis).—Dr. Duchenne, of Boulogne, who has done most to throw light upon this disease, gives as its fundamental characters "the progressive abolition of the faculty of coordinating movements, and apparent paralysis contrasting with the integrity of the muscular power." The disorder has many other striking points of interest, many only transient or occasional, but some of them always preceding or accompanying the muscular incoördination. The chief lesion in tabes dorsalis is sclerosis of the external bands of white fibres forming the posterior columns of the spinal cord.

The disease is much more common among men than women, and usually appears about the time of middle life, but may attack young or very old men. The premonitory symptoms may extend over a considerable number of years.

The *first period*, or period of lightning pains, as Charcot terms it, is marked by pain of a boring, shortening, or constrictive character affecting the legs, the back, or the

trunk, coming on in paroxysms at varying intervals of time. Among the occasional symptoms of this period are—

1. Nocturnal incontinence of urine.
2. Seminal losses.
3. Exaggerated virile power.
4. Transient paralyses, or symptoms of nerve irritation. Dimness of vision of one or both eyes, due to grey atrophy of the optic nerve, and intense contraction of the pupil, are common. There may also be transient hemiplegia, transient paralysis of the third, the fifth, the sixth, or other cranial nerves.
5. Joint affections; these may appear in the early or late stages of the disease. The joints affected become enlarged, fluid appears in them, the cartilages and ligaments become destroyed, and dislocations occur.
6. Gastric crises may occur, as in other spinal diseases; these are marked by attacks of intense pain, starting from the epigastrium and extending over the body, accompanied with sickness, vertigo, cardiac pain and palpitation.

In the *second period*, when the disease has fairly established itself, the patient suffers from motor incoördination and deficient sensibility of the lower extremities. He feels as if his feet were wrapped in cotton-wool or india-rubber; when the eyes are closed, in the dark, he staggers or falls; when his knees are crossed, and the ligament of the patella is tapped, there is no answering contraction of the muscles of the front of the thigh as in the normal state; or, in other words, the *patellar reflex* is absent or deficient. In this stage the early symptoms above mentioned may more or less persist.

In the *third phase* of the disease, real paralytic debility sets in; nutrition becomes affected, the upper extremities are invaded, there is a tendency to bed sores and cystitis, and death sooner or later is the result.

Treatment.—Rest and the administration of tonics with a view to the improvement of the general health is the most hopeful treatment which can be followed. Iodide of potassium in large doses, nitrate of silver, phosphorus, and other drugs have been tried, but without much success.

Pseudo-hypertrophic Paralysis.—This is a disease which seems chiefly to attack children. Clinically it is marked by two periods. In the first, which may last a

few months to a year, there is partial paralysis of the lower extremities with no apparent hypertrophy. In the second period, which may extend over a long time, the loss of muscular power becomes general, while the muscles become much enlarged, especially those first attacked. Sooner or later the mental faculties become impaired, nutrition becomes faulty, and death ensues.

No constant nervous lesion has been found to account for this condition, but examination of the muscles shows that the hypertrophy is due to an accumulation of fat between the muscular fibres and the ultimate disappearance of most of the muscular structure. No treatment is of any avail in the later stages of the disease, but Duchenne says that the regular application of the Faradaic current, with shampooing of the affected muscles, may arrest it in its earlier stage.

Paralysis Agitans (Shaking Palsy).—This is a disease which is usually confined to persons advanced in life; it is very rare before the age of fifty, and generally runs a lingering course. The chief symptom is tremor, evident in every part, but the nodding of the head and the shaking of the hand and arm being the most apparent. Accompanying the tremor is a rigidity of muscles, and a remarkable slowness in executing designed movements, simulating paralysis. There is, however, no absolute loss of muscular strength, as can be shown by using the dynamometer. Sleep, in the advanced stages of the disease, cannot be induced.

In walking the gait is uncertain, and there is often a tendency to run forward or to fall backwards.

As the disease advances cramps are commonly complained of, there is an intense feeling of prostration and uneasiness, nutrition finally fails, and death comes on, it may be twenty or thirty years after the first symptoms have shown themselves. The lesions noticed after death cannot be said to be characteristic. The central canal of the cord has been found choked up, with some proliferation of cells in its neighbourhood, and pigmentation of ganglion cells.

The causes assigned for the disease are age, shock, exposure to damp, cold, and irritation of peripheral nerves.

Treatment.—There are apparently cases which tend to spontaneous cure, but no specific is known for this disease.

Chorea (St. Vitus's Dance).—Chorea is a disease of

youth, its chief manifestation being a spasmodic twitching of muscles of one or both sides of the body, and which tends to run a comparatively short course. It is very frequently associated with an attack of rheumatism, following, preceding, or accompanying it; a mitral regurgitant heart-murmur is often present, and the disease frequently recurs at longer or shorter intervals.

In other cases it occurs in delicate young people, from some mental or moral shock, or in young chlorotic females.

A form of the disease, known as post-hemiplegic hemichorea, also sometimes occurs after hemiplegic attacks; and, finally, the disease has been known to affect very old persons, and is then spoken of as senile chorea.

Symptoms and Course.—In a well-marked case the patient at first may only be noticed to be fidgety and clumsy in his movements, dropping everything he touches, sliding his feet over one another, making sudden and startling grimaces, speaking with difficulty, and making choking noises in his throat. Very often one side only is at first affected. In very severe cases the patient may have to be kept in bed, or from the extreme nature of the convulsive movements, sleep or rest may be impossible, and death may occur from exhaustion. The general health always suffers; the patient is pale, wanting in energy and mental capacity, and occasionally there is more or less anæsthesia of some parts of the body.

Usually, in from a few days to two or three weeks, the twitchings diminish and finally disappear, the patient returning to his usual state of health.

Pathology.—No constant anatomical changes have been proved to exist in any part of the nervous centres, but the following are the chief causes assigned :—

1. Embolism of the smaller arteries supplying the corpora striata and adjacent parts; due to the escape of small particles from the mitral valve.

2. Thrombosis, due to rheumatic affection of the small vessels.

3. A general tendency to hyperæmia of the nerve centres—brain and spinal cord.

Treatment.—In mild and moderate cases the tendency is towards spontaneous cure, and this may be aided by the administration of tonics, especially iron and small doses of arsenic. In the more severe cases sedatives may be given, and every effort used to produce sleep. All excitement should be avoided, and good food in suitable

quantities should be carefully administered. Any rheumatic tendency should be carefully watched and treated.

Epilepsy.—Epilepsy is a disease characterized by the more or less frequent occurrence of convulsive fits, accompanied by loss of consciousness. It is most common in youth, about the time of puberty in both sexes, but may make its appearance at any age. There is a great variety in the mode and kind of attacks and in the phenomena accompanying them. The disease is not incompatible with great robustness of body and keenness of mind, or it may be found in the strumous and rickety, and may be associated with weakness of mental powers amounting to insanity. The fits may succeed each other with the greatest rapidity, or they may be of the rarest possible occurrence. At least two well-defined classes of the disease are found; the one a mild form, the *petit mal* of French writers, the other a severe form or *haut mal.*

In the former the symptoms may be only those of vertigo, transient in character and marked by little or no loss of consciousness. After the attacks there may be slight headache and inaptitude for work. In the latter the patient falls down insensible, the body for about thirty seconds is rigid, the breathing ceases, and the face is flushed; this stage is soon followed by violent convulsions, as if all the motor cells in the body were discharging impulses to the muscles. There are violent flexions and extension of the limbs, the head moves strongly, the tongue is thrust out and rolls about in the mouth, causing the saliva to froth and escape through the lips, the eyes roll from side to side, the heart beats quickly, and the flushing of the first stage is succeeded by pallor. The convulsions do not as a rule last beyond two or three minutes, and the patient may then at once recover consciousness, or, as more commonly happens, falls into a heavy noisy sleep, from which he awakens with a headache, tired, and sore in every part, but without any remembrance of the fit. There is no periodicity in the occurrence of these attacks, but it frequently happens that their first appearance is at night and during sleep. The following are some of the points which have been noticed in connection with epileptic attacks:—

1. *The Epileptic Cry.*—In many patients the attack is ushered in by a distressing shriek, possibly due to the forcible expulsion of air through the glottis.

2. *The Epileptic Aura.*—There is some warning of the

attack in about half the total number of cases. The patient may feel as if a cold breeze were blowing on some part of the body, or there may be other disturbance of general or special sensibility. A peculiar odour, taste, lights before the eyes, or visions terrible or pleasing, sounds unintelligible, or apparently voices commanding, entreating, &c., may precede the attack.

3. *Mania.*—In some cases the patient becomes like one possessed with an evil spirit. He may be seized with an impulse for self-destruction or murder, or unreasonable violence of any character. In other cases, he is only morose, ill-tempered, suspicious, or may be excited to unnatural laughter and gaiety. He may have delusions, very commonly of a religious character; he sees visions, prophesies, raves, and finally the epileptic seizure comes on.

Causes.—In epilepsy, hereditary predisposition is strongly marked. The disease itself may have occurred in the family in preceding generations, or there may have been only a tendency to neurotic affections, such as hysteria and insanity; it is very likely to appear in families where there has been frequent intermarriage between near relatives. Sudden shocks, mental or moral, may start the disease, and masturbation, excessive venereal indulgence, and excessive drinking have been assigned as probable causes. Epileptiform attacks occur in the course of disseminated sclerosis, in blood-poisoning from kidney disease, in syphilis, and in other diseases where there is irritation of the nervous centres.

Treatment.—During an attack the only thing to be done is to prevent the patient hurting himself. Some soft substance should be placed between the teeth to prevent injury to the tongue, and the head and limbs should be protected by pillows or other similar materials.

No epileptic person should ever be allowed to engage in any occupations in which a fit might prove dangerous. In the intervals between the attacks, bromide of potassium, in thirty- or forty-grain doses or more, should be given three or four times a day. Belladonna may with advantage be added, and it is sometimes useful to give these drugs in gradually increasing doses. Arsenic, iron, nitrate of silver, and other metallic salts, have also often proved useful, and where syphilis is suspected, iodide of potassium may be given. Inhalation of nitrite of amyl or chloroform have been found useful in warding off attacks.

Pathology.—No constant anatomical lesions have been found to explain the causes of epilepsy.

HYSTERIA.—Hysteria, as the name implies, is a nervous disease which has been ascribed to uterine derangement, but as it is not unknown among men, this cannot be considered its invariable cause.

The commonest symptoms of hysteria are attacks of laughing or crying, or both together, with a general tendency to exaggerate trivial maladies or invent new ones. The disease is most common among young unmarried females and women about the change of life, and is often associated with menstrual derangement and ovarian tenderness. The subject of hysteria may simulate any disease she knows anything about, and there are no mental and moral vagaries which are not possible to her. It is only possible here to indicate some of the forms which hysteria may take:—

1. Globus hystericus. This symptom is very common. The patient complains of something rising in the throat, choking her, or preventing swallowing.

2 Aphonia. Frequent attacks of loss of voice may be a marked symptom.

3. Cough, with or without spitting of blood, which may come from the mouth by biting the tongue, &c., or which may be purposely swallowed and then ejected, is a favourite malady.

4. Vomiting of food or blood, or the introduction into the vomit of strange foreign matter, is not uncommon.

5. Abnormal appetite, or pretence of doing without food or drink.

6. Retention of urine, with a morbid craving for catheterism.

7. Epileptiform convulsions, which in many cases simulate true epilepsy, and are difficult to diagnose from it, may occur.

8. Paralyses of various kinds are often found. Thus the patient may be apparently paraplegic, hemiplegic, or partial or complete anæsthesia may be strongly marked, no amount of irritation apparently giving any pain. Hyperæsthesia in the opposite limbs may accompany one-sided anæsthesia, or these may replace one another.

9. Contractions of limbs may be a prominent symptom, the legs or arms being twisted into the most unnatural positions.

10. Catalepsy, trance-like conditions, visions, and immoderate lying, are very frequent.

11. Skin eruptions, bleeding wounds, &c., are often produced.

Treatment.—The main object should be to improve the general health, and remove any cause of irritation. If the menstrual function is at fault, that should be regulated. Change of air and scene, cold bathing, and regular exercise, with a mild, unstimulating diet, should be ordered for robust persons, and where the patient is anæmic and badly nourished, good food and fresh air are the first requisites. Sedatives, such as bromide of potassium, are often useful, and assafœtida, valerianate of zinc, are also useful. No morbid cravings should be indulged, and sharp treatment is often more effectual than kindness or sympathy. It is well to remember that there may be serious physical disease along with hysteria, and care should always be taken to search thoroughly for organic disease.

NEURALGIA. — All pain is necessarily nerve-pain, or neuralgic, but the term *neuralgia* is properly applied to pain, generally paroxysmal, following the distribution of certain nerves, and not depending upon any coarse changes in the nerve structures.

Causes.—In a very great number of cases there is a strong hereditary predisposition to neuralgia, hysteria, epilepsy, or insanity. Exhaustion from loss of blood, over-lactation, wasting disease, excessive mental efforts, alcoholic excess, worry and anæmia, however produced, are strong predisposing causes. Exposure to cold draughts and to damp, with insufficient exercise, is a common exciting cause. Neuralgia is seldom found in youth, but becomes common in middle age and later life. Malarial influences, and shock, as from a fall, railway accidents, &c., may produce neuralgia.

Among the diseases which simulate neuralgia we find syphilis, aneurism, strumous caries, and new growths of various kinds, affecting nerves or nerve-centres.

Forms of Neuralgia.—We may classify neuralgias, according to the parts affected, as superficial and visceral.

Among the superficial nerves affected, the trigeminal and the sciatic are the most important; but the occipital, the intercostal, and the brachial nerves are often attacked.

Any of the viscera may be the subject of neuralgic

pains. In women, the uterus and ovaries are especially frequently affected.

Symptoms.—The pain of neuralgia varies much in character. It is usually paroxysmal, and may be stabbing, boring, darting, &c.

Tic-douloureux, or epileptiform neuralgia, an affection of some branch of the trigeminal, is one of the severest forms. It is said to be often associated with a tendency to insanity and suicide. The agony is extreme, and the slightest cause (exposure to cold, pressure, mastication of food) may bring on an attack. The patient rubs the part affected, and this is at times done so often and so violently as to remove all the hair from the skin, leaving it smooth, as if shaven closely. During the attack there is often spasm of the muscles of the face, redness and swelling, and running of watery fluid from the eyes and mouth.

Sciatica is another troublesome form, and may come on in paroxysms, or there may be a constant aching, made worse by movement.

Migraine, or *Megrim*, is a form of neuralgia marked by headache on one side, of an intense shooting character, with disturbance of vision or hearing. The patient is incapable of mental exertion, and often suffers from severe vomiting. It is rare after the age of thirty.

Heart Neuralgia, or *Angina Pectoris*, is a special form of disease, which is considered under the head of "Diseases of the Heart."

The presence of tender spots, especially where the nerves escape from bony canals, often accompanied by partial anæsthesia of surrounding parts, is very often found in neuralgia associated with malaria.

Treatment.—This must be constitutional and local. In most cases a sound nutritious diet is of great importance, and care must be taken to avoid depletory measures. Iron, quinine, cod-liver oil, and arsenic are often serviceable; and sedatives, such as chloral, croton-chloral, bromide of potassium, opium, &c., frequently relieve pain. Externally, aconite ointment or liniment, is useful in trigeminal neuralgia. Chloral and camphor, in equal parts, make a good local application in intercostal and facial neuralgia. In sciatica, hot poultices, hypodermic injections of morphia, and strong counter-irritation, are all serviceable.

Neuralgia is often completely intractable, and the

temptation to abuse alcohol, morphia, &c., is very great, so that care has to be taken in prescribing them.

Menière's Disease (Auditory Vertigo). — This disease depends upon some irritative lesion of the auditory nerve in the semicircular canals, or in some other part of its course. It is characterized by sudden attacks of vertigo, with noises in the ears, pallor of the surface, sickness, and an inclination to fall in some particular direction. There is no loss of consciousness, and headache is not common. The attacks are not of long duration, but have a tendency to recur.

Treatment.—When attacks come on the patient should at once lie down. The tincture of gelsemium (non-officinal) in ten-minim doses, three times a day, is recommended by Dr. Ringer.

Tetanus (Lockjaw).—Tetanus is a disease characterized by excessive reflex excitability of the nervous centres, and by constant irritation of the motor nuclei, leading to persistent muscular spasms in every part of the body.

Causes.—Tetanus seems to be nearly always due to injuries, especially to lacerated wounds when foreign bodies are embedded in the tissues. Exposure to cold and wet, and a hot climate, are strong predisposing causes. In new-born children, attacks have been ascribed to faulty management of the umbilical cord.

Symptoms.—These may come on in a few hours, or most commonly in from four to fourteen days after injury. The muscles of the jaws and neck are first affected by stiffness and painful spasm; this spreads by degrees to the other voluntary muscles. When this condition is fully established, the least irritation brings on powerful general spasms, in which the body is often thrown into an arched form, resting only on the head and heels (opisthotonos). The respiratory muscles become fixed, the surface becomes livid, the face is distorted, the eyeballs are protruded. Or the body may be curved forward (emprosthotonos), or to one side (pleurosthotonos). Between the paroxysms the body is rigid, the facial muscles fix the mouth in a peculiar manner (risus sardonicus), and there is always more or less pain. The mind remains clear. The temperature is rarely high; the pulse is weak and quick, and the skin often breaks out in sweats.

The majority of cases terminate fatally. In hot climates a few hours of tetanus may suffice to kill; but generally

the patient lives three or four days, or perhaps for a much longer time.

Pathology.—The peripheral nerves at the seat of primary injury have been found swollen and inflamed; and the spinal cord and its membranes, as might be expected, have been found congested, and the seat of small extravasations; but no other changes are constant.

Treatment.—Any local source of irritation should if possible be removed, or the nerve leading from the injured part may be cut. During the spasms chloroform inhalations are useful. Cases have recovered in which Calabar bean or other sedatives have been administered; but there has been no constant success followed by any known method of treatment.

PARALYSIS OF SPECIAL NERVES.—The cranial nerves may be affected with paralysis, with or without general nervous lesions. The commonest cause of local paralysis is syphilis. Any new growth, tubercle, cancer, &c., may produce similar effects, and oculo-motor paralyses are not uncommonly among the premonitory symptoms of locomotor ataxy.

Paralysis of the third nerve, when complete, gives rise to ptosis (drooping of the eyelid), external squint, double vision, and dilatation of the pupil.

Paralysis of the fourth nerve causes upward squint from affection of the superior oblique muscle.

Paralysis of the fifth nerve, if complete, causes loss of sensation over nearly the whole side of the face and head, the nose, gums, tongue, and palate, and the temporal, masseter, and pterygoid muscles are paralyzed. Disturbances of nutrition are also likely to occur, giving rise to ulcerations of the cornea, nasal mucous membrane, &c. More commonly only part of the fifth is affected.

Paralysis of the sixth nerve, which supplies the external rectus, gives rise to internal squint.

Paralysis of the seventh (facial) nerve, or Bell's paralysis, is rather a frequent affection. It seems to arise frequently from exposure to cold draughts, and is often a result of fracture or other injury to the base of the skull. The symptoms are striking. The affected side becomes smooth and expressionless; the eyelids can be opened but not closed; the tears run over the face from paralysis of the tensor tarsi; the ala nasi becomes flaccid; the mouth, from paralysis of the buccinator, gets clogged with food

and mucus. The sound side of the face has all its normal features exaggerated from the unopposed action of its muscles, and appears wrinkled, drawn up, and deformed. There is no anæsthesia, and the paralyzed muscles waste rapidly. If the lesion involves the chorda tympani the salivary secretion may become copious and watery, and the gland degenerates. If the lesion is higher still, there are usually other symptoms of nerve injury.

Other motor nerves throughout the body may suffer from paralysis. The *musculo-spiral* nerve seems to be liable to be affected by exposure to cold and wet. The symptoms then are much the same as in wrist-drop from lead poisoning, with this exception, that the supinator longus is never affected in lead poisoning, but always in paralysis from cold, and also that in this form the paralyzed muscles do not lose their electrical excitability, but do lose it in plumbism.

Treatment.—In these various forms of paralysis care should be taken to avoid exposure to cold and damps. If syphilis is suspected, iodide of potassium must be given. The daily use, for a few moments at a time, of the constant or intermittent current is a valuable remedy.

Functional Spasms.—The term "functional spasm" has been applied to a loss of nervous power over certain muscles or groups of muscles which have been over-used, and which only manifests itself when attempts are made to put the muscles into action.

Writer's cramp or *scrivener's palsy* is a well-known form of this disease, which sets in whenever a pen is used. The first symptoms are a sense of fatigue and loss of power. Often jerking movements set in, which throw the pen out of the hand, and the progress of the disease is towards complete disorganization of the co-ordinated movements necessary for writing, although the muscles may remain useful for other purposes. There is generally some general diminution of power in the affected muscles.

Wryneck is another form which leads to jerking movements of the head, often ending in fixation in some particular position.

Pianists, tailors, soldiers, singers, &c., may all suffer from nervous affections peculiar to their trade.

Treatment.—The chief indication of treatment is complete rest of the parts affected. Tonics should be given, and Dr. Poore recommends the regular use of a weak continuous current.

Sun-stroke—Heat-stroke.—These are affections which are produced by exposure to excessive heat under circumstances which check the free action of the skin and other emunctory organs. Soldiers, loaded with their accoutrements, exposed to a hot sun, labourers, stokers, and others, are most liable to be attacked. The onset is sometimes sudden, sometimes gradual. The symptoms of a developed attack are loss of consciousness, rapid noisy breathing, a quick, weak, irregular pulse, flushed face, and injected conjunctivæ. Sometimes there are convulsions. The chief premonitory symptoms are headache, nausea, vertigo, prostration, dryness of skin, constant tendency to micturate. The death-rate from sun-stroke is usually very heavy.

Treatment.—The patient should at once be protected as much as possible from the heat; all tight clothing should be made loose or removed, and douches of water, tepid if possible, should be applied for some time at short intervals to the head, neck and chest. Subsequently, if the patient does not become conscious, the head may be shaved and ice-bags applied, and the bowels relieved by purgatives or enemata. Care should be taken not to bleed. After an attack of sun-stroke removal to a temperate climate and great care as to mode of life is imperative, as permanent effects of a serious character, such as epilepsy, attacks of mania, susceptibility to the slightest rise of temperature, often follow recovery.

The disease is more likely to arise when the sun is near the horizon—*i.e.*, in the morning or evening, than when it is in the meridian.

PART V.

MIDWIFERY.

(*For an account of the Female Genital Organs see "Anatomy."*)

DEVELOPMENT OF THE EMBRYO.

THE OVUM.—Lining the posterior surface of the ovary is a layer of cubical cells called the *germ* epithelium. From these cells the *ovigerms* are developed, by the passage of a group of germ epithelia into the tissue of the ovary; of this group only one becomes developed into an ovigerm, but the process takes place to such an extent that thousands of these ovigerms become developed in a lifetime, so that beneath the posterior wall of the ovary lie an enormous number of cells, capable of development. The farther history of the process consists in the development of a *Graafian vesicle.* This takes place as follows: one of the ovigerms, getting more nutrition than its neighbour, acquires round about it a quantity of fluid. It travels at the same time deeper into the substance of the ovary nearer to the larger trunks of the ovarian artery. By-and-by the vesicle consists of a capsular wall lined by a layer of cells, the *tunica granulosa,* and at one spot, amongst a heap of cells—the *discus proligerus*—lies the ovigerm, now become an ovum. The ovum may be seen to consist of:—1. A cell wall—the *zona pellucida.* 2. Contents—*the yelk.* 3. A nucleus—the *germinal vesicle.* 4. A nucleolus—the *germinal spot;* in fact a typical cell. By-and-by the Graafian vesicle ruptures and allows the ovum to escape. The *rent in the vesicle* gets filled up at first by blood, and afterwards the torn edges become active, and a process of ulceration is set up. This is most highly developed in the vesicle belonging to the impregnated ovum. In this condition the blood effused loses its colour, and white blood corpuscles find their way between the torn surfaces; the consequence is, a yellow or buff colour is imparted to the mass, and a *corpus luteum* is said to exist. This body is

but ill-developed when impregnation has not taken place, but when it has, the body remains visible until the end of lactation, or until the child is weaned. The escaped ovum now finds its way to the mouth of the Fallopian tube, towards which it is carried by the *fimbriæ*. Here it meets the spermatozoa, and, from the intermingling, changes are set up which end in the development of the embryo. The ovum now finds its way down the *Fallopian tube* into the uterus, occupying about a week in its passage, and becomes implanted, as a rule, at the fundus. Here are developed the various coverings of the embryo. The spot at which the ovum becomes fixed becomes the *decidua serotina* or *placentalis*—*i.e.*, the placenta. Growing up from the edges of this is a reflection of mucous membrane, which by-and-by comes to enclose the whole ovum or embryo, and is called the *decidua reflexa*. At about the fourth month the lining membrane of the rest of the uterus leaves the wall, and becoming incorporated with the decidua reflexa, goes by the name of the *decidua vera*.

The changes going on *within the impregnated ovum* itself ever since it left the ovary are progressive and important. First, the germinal vesicle and spot disappear, and the *cleavage* of the yelk proceeds. This goes on until the segments become reduced to small spheres or cells with clear nuclei (blastides), and a membrane forms on the surface of the yelk, called the *blastoderm*. At a spot *in* this membrane a group of cells become differentiated into layers, and close microscopical examination will show that three layers here exist, constituting the three primary embryonic layers—viz., the *epiblast*, the *mesoblast*, and the *hypoblast*. From the epiblast, the outer layer, the cutaneous and cerebro-spinal systems arise; the hypoblast, the inner, comes to form the epidermal lining of the alimentary canal, with its diverticula; whilst the mesoblast, dividing into two the *somato-pleure* and the *splanchno-pleure* layers, forms bones, muscles, vessels, &c. Hence there are four layers, and they behave themselves as follows:—the two inner, the hypoblast and the splanchno-pleure layer of the mesoblast, grow *downwards* to enclose the *yelk*; whilst the two outer, the epiblast and the somato-pleure layer of the mesoblast, together pass *upwards* on all sides of the embryo, and meeting over the back form the *amnion*. Hence, at one period, there is a sac below consisting of the yelk and its coverings, and a

sac above consisting of the amniotic tissues. All these changes happen within the zona pellucida or cell wall, which now develops villous tufts from its surface, and is known as the primitive chorion. The outer layer of the epiblast, thrown off after the formation of the amnion, goes by the name of the *false amnion;* this now adheres to the inner aspect of the primitive chorion, and as a result the *true chorion*, with well-developed villi, becomes established. The amniotic fluid now increases in quantity, until the embryo becomes completely enveloped in the folds of the amnion. As a consequence, there are now four coverings to the embryo, and at the time of the rupture of the membranes they consist of, from without inwards, the decidua vera, the decidua reflexa, the chorion, and the amnion. The introduction of the finger to rupture the membranes would go through the tissues in the order mentioned, and the *liquor amnii* would then escape. This fluid consists of water, chloride of sodium, urea, &c., with a few hairs and scales from the body of the fœtus.

As the embryo develops the connection between it and the yelk becomes narrower and narrower, until at length a small pedicle, the vitello-intestinal duct, is all that connects them with each other. The canal in front of where the duct joins the body is called the *fore-gut*, the canal behind the *hind-gut*. Growing out, from the hind-gut at a spot near by what is to become the anus, is the allantois. *The allantois* commences as a bud from the lower part of the gut, and consists of the same structures as the gut—viz., the hypoblast internally, and the splanchno-pleure layer of the mesoblast externally. As the bud develops, it finds its way from the front of the body, outwards between the yelk and the amnion, until it reaches the chorion, where it spreads all over the villous tufts at first, but afterwards develops only at one spot to form the placenta. The part of the allantois which remains within the body becomes the *bladder* and *urachus*, the part outside the body becomes the *umbilical cord* and the *placenta*. Arising from the internal iliac arteries, on either side, are the two *hypogastric arteries*. They carry venous blood, and pass first out at the umbilicus on the allantois, and then come to be associated with its different parts. Along the umbilical cord they are called *umbilical arteries*, and run on to the placenta. Here the venous blood they contain is changed to arterial, and the *umbilical vein* carries the blood back to the body, first to the liver, and then by the *ductus venosus* to the inferior vena cava. The *umbilical*

cord consists then of the following structures, from without inwards:—1. A layer of *amnion*. 2. The *jelly of Wharton;* this tissue consists of fine branched cells with soft intercellular substance yielding mucin. 3. *Two umbilical arteries*. 4. *One umbilical vein*. 5. The remains of the *yelk sac*. 6. A *knuckle of intestine* at the inner end. Its average *length* is eighteen inches; it is said to be long when it measures three feet, and short when it measures nine inches only.

The placenta is inserted on the wall of the uterus, usually its fundus, and has the umbilical cord attached to its free surface. The *diameter* of the placenta is on an average about nine inches; and the cord is inserted either into its centre, *central insertion*, or into its margin, *marginal insertion*. The inner surface of the placenta is smooth, being covered by the amnion; the outer or attached surface is flocculent, and on careful examination can be made out to consist of separate areas, presided over by a branch of the umbilical artery, constituting its fronds or *cotyledons*. At birth the margins look lacerated and irregular, consisting of the torn membranes that are furled around and shrivelled up owing to their elasticity and previously distended state.

MENSTRUATION.

When a woman approaches maturity, there occurs a monthly discharge from the uterus—the *menses*. This discharge continues normally during the child-bearing period, except during pregnancy and suckling. This discharge is invariably preceded by pain and weight in the back; aching in the thighs, swelling and tenderness of the breasts: and often with headache and lassitude, and disorder of the stomach.

The cause of the menstration may be the presence of an ovum, finding its way down the passages; but the connection between ovulation and menstruation cannot be definitely affirmed. The menstrual blood is bright red; it does not coagulate readily, owing to the action of the acid secretion of the vagina.

The most common disorders of menstruation are:—

1. Emansio mensium—*i.e.*, the non-appearance of the discharge at the proper age. Twelve to fifteen is the usual age at which menstruation commences, but it may be delayed to twenty-one. The menses may not appear

from various abnormal conditions. (*a*) The absence of the ovaries or uterus; in such subjects there is no exhibition of sexual activity. (*b*) The canal of the uterus or the vagina may be *closed* (atresia), staying the passage of the menstrual fluid. (*c*) Disordered state of the health will cause a delay in the appearance of the menses. In girls that exhibit all the outward symptoms of robust health, that possess even a *sanguine* temperament, there may occur at intervals of a month severe headaches, sickness, aching in the back and thighs, but no discharge. By-and-by this condition tells on the patient, and instead of the robust look the aspect becomes waxen, puffy, and pallid; the appetite is deficient or depraved; the tongue looks pale and the bowels are torpid; hysteria supervenes. The name given to this condition is the green sickness, or chlorosis.

Treatment.—Light diet, exercise, mild and continued purgatives, with a large dose of aloes and iron, and a warm bath at the time the flux is expected, provided no visceral disease, such as kidney disease or phthisis, is present. When atresia exists relief must be given by incision.

2. Amenorrhœa, or suppression of the menses, may be caused by pregnancy, frights, or taking cold during menstruation, or by the patient falling into a low state of health.

It requires the same treatment as the former. Emansio mensium and amenorrhœa usually go under the common name amenorrhœa.

3. Dysmenorrhœa, or painful menstruation. This may take one or other of the following forms:—

a. Mechanical, in which there is a narrowing of the passages at some point, either in the uterus, at the os, or in the vagina, caused by flexion or displacements of the uterus; or stricture at the os or cervix caused by cancer, fibroid tumour and polypi. The obstruction may, on the other hand, be in the character of the *fluid* discharged, as shreds of mucous membrane not unfrequently present may be too large to pass through the os, and so give rise to pain.

b. Inflammatory. In many cases inflammation may so narrow the os that the menstrual fluid escapes with difficulty.

c. The nervous. To this group are assigned all cases in which a cause cannot be made out.

d. Ovarian. By which is meant the pain frequently felt before menstruation in the neighbourhood of an ovary, and ascribed to the rupture of a Graafian follicle and escape of an ovum.

Treatment—Rest, opiates, hot baths to relieve pain,

and general constitutional treatment continued for some time. When any local change is found it must be treated. Displacement must be corrected; inflammation subdued; dilatation persevered with, if stricture exists; tumours must be removed; and if nothing will do, incisions around the os, best done by a knife.

4. Menorrhagia, or profuse menstruation; the causes are:—*a.* Changes in the structure or position of the uterus. *b.* Fibroid tumours. *c.* Congestion of uterus, and retained portions of the placenta, moles, &c. *d.* Any general constitutional illness, as fevers, kidney disease, &c.

Treatment.—To *check the hæmorrhage* employ—1. Rest. 2. The administration of ergot and acetate of lead. 3. Plugging the vagina or uterus. 4. The application of styptics to the inner surface of the uterus, such as nitric or carbolic acids, or a solution of ferric chloride. These remedies should be employed in the order here enumerated. After the hæmorrhage is checked, remove the cause if possible, and pursue a general tonic treatment.

Vicarious Menstruation.—Sometimes when the menses are absent, there is a supplemental discharge of blood from the stomach, nostrils, rectum, or from a wound, when the menstrual time comes round.

The *treatment* is to allay the hæmorrhage when very profuse, and to endeavour to restore the normal discharge.

Cessation of Menstruation.—This occurs at various periods in different women, ranging from thirty-eight to fifty-five; but forty-five may be called the average. It is often attended with various disorders of the health, such as headaches, giddiness, and other signs of irregular distribution of blood; and the discharge is usually very irregular, now profuse, now scanty, now missing a month, before it ceases altogether.

Leucorrhœa is the name given to a white discharge escaping from the female genitals. It may flow from different spots in the canal:—

1. From the *vulva;* this form is most common in children, and almost invariably results from worms, and requires treatment accordingly; the discharge is at times profuse and forms crusts over the aperture.

2. From the *vagina*, in young married women; the discharge is plentiful, white, and acid in reaction.

3. From the *cervix uteri*, in women who have borne children; it is a thick, tenacious, transparent fluid, with an alkaline reaction.

4. From the *cavity of the uterus*, in young unmarried women; the discharge is like that from the cervix, but more fluid.

5. From the Fallopian tubes; it is then called *tubal* leucorrhœa; this is a disease that can only be guessed at.

Independently of a distinct history, it is impossible at times to be sure that it is not gonorrhœa the patient is suffering from.

Treatment—General tonic and dietetic treatment is indispensable; but local treatment must in most cases be resorted to. For this purpose the following methods must be used:—Cleanliness, injections of tepid water first, and then washing out the part with astringent lotions of alum, acetate of lead, &c., will probably suffice in cases of vaginal leucorrhœa. When, however, the leucorrhœa is cervical, or intra-uterine, a speculum must be used and stronger astringents employed to touch the inflamed spots. First mop out the cavity of the uterus with a piece of cotton-wool wrapped round a uterine sound; then touch the surface with nitrate of silver in solid form, or fuming nitric acid, or acid nitrate of mercury.

Signs of Pregnancy.—When a healthy woman, between the ages of fifteen and forty-five, experiences a cessation of the menses, morning sickness, swelling of the breasts, and enlargement of the abdomen, the suspicion is that she is pregnant.

When we analyze the symptoms of pregnancy, we find that they may be divided into two classes, the *rational* and the *sensible*. The *rational* are those from which, without investigating the state of the uterus itself, we reason or infer that the woman is pregnant; the *sensible* are those signs of the presence of a fœtus, detected by exploration of the uterus itself.

Rational Signs.—1. *Cessation of the menses.*—This is generally the first token by which a woman believes herself to be pregnant; but although *generally a true* sign, it is *not unfrequently a fallacious* one. For, in the first place, pregnant women may have a discharge resembling the catamenia, during the term, or at least for the first two or three monthly periods. In the second place, they may be absent from disease when there is no pregnancy. Again, girls may become pregnant before they have ever menstruated, and women soon after one pregnancy, before the menses have returned.

2. *Morning sickness.*—During the early months of

pregnancy an attack of sickness and retching on first rising from bed in the morning is very common. It may last only for a few minutes, or may be so severe and permanent as to interfere seriously with the nutrition of the patient. It may begin, too, either immediately after conception, or not till the fifth or sixth week. It generally ceases about the third month, but sometimes lasts longer.

3. *The state of the breasts.*—About two months after conception, signs of functional activity generally manifest themselves in the breasts. They become larger and knotty, and feel aching and tingling; the *areola* round the nipple darkens; the follicles become excessively developed; and a small quantity of milky fluid oozes out. But these signs by themselves are not to be relied on.

4. *Quickening.*—What is quickening? Some authors say it is the peculiar sensation caused by the first movements of the fœtus; others assert that it is caused by the sudden rise of the uterus from the pelvis into the abdominal cavity. It is attended by a peculiar faint sensation, usually felt about the end of the fourth month. As a sign of pregnancy it is almost valueless.

5. Kiestein is often present in the urine. It is a substance found floating on the top of the urine, like a thin film; it consists of triple phosphates, with numerous fungoid growths.

6. The vagina becomes of a deep purple colour.

7. General digestive derangement, associated at times with diarrhœa, or again with constipation.

The most that can be said for any one of these signs is that they afford corroborative evidence merely.

Sensible Signs.—1. *Enlargement of the abdomen* usually becomes perceptible about the end of the second month. In the fourth month the fundus uteri may be felt in the hypogastrium; in the fifth, halfway between the umbilicus and pubes; in the sixth, at the umbilicus; in the seventh and eighth months it rises still higher towards the ensiform cartilage; and in the ninth it attains its maximum elevation, and sinks again in the last fortnight before delivery.

The tumour formed by the enlarged wound is firm, elastic, well defined in its outline, and not lobular. It is distinguished from ascites, by the fact, that the most prominent part of the tumour is always *dull on percussion;* whilst if the patient lie on her back, percussion

will elicit a clear sound all round the tumour; in fact, where the bowels are.

Swelling of the abdomen is a most important sign of pregnancy, but yet, since mere swelling may also be a consequence of *ascites;* of *enlarged liver* or *spleen;* of *ovarian tumour;* of *tympanites;* and of *fœcal accumulations in the colon*, care must be taken to investigate every concomitant symptom.

2. *Ballottement.*—This is a very valuable sign of pregnancy, inasmuch as it proves, physically, that *something is suspended in the womb, floating in a liquid.* It is ascertained thus:—Let the patient be in the upright, or at least semi-recumbent posture. Apply the left hand over the fundus uteri, and place the forefinger of the right hand over the cervix uteri; then jerk the right forefinger upwards, and the fœtus will be felt to *bob* down upon it two or three times. This test is most available about the fifth and sixth months.

3. The *state of the cervix uteri*, as ascertained by vaginal examination, is a very important sign. In the virgin state, it feels hard, small, and pointed; in the first month of pregnancy it becomes softer and larger, and the transverse slit more open. In the second month the cervix can be easily reached by the finger; its edges have lost their lip-like figure, and now form a ring—smooth in the primipara—rugged in multiparæ—around the os uteri. As pregnancy advances, the cervix becomes shorter, higher up, points to the upper part of the sacrum, and at last becomes merely a smooth globular mass, with a soft ring in its centre. These changes in the cervix, and the increased volume of the uterus itself, as detected by examination, are the surest signs of pregnancy in the early months.

4. *The pulsations of the fœtal heart.*—Careful examination of the front and sides of the abdominal tumour, after the fifth month, will hardly fail to detect the pulsations of the heart of the fœtus, if it be alive, beating generally at the rate of 150 in a minute; it is usually heard best below and to the left of the umbilicus.

5. *The placental souffle*, and

6. *The uterine souffle.* These may be usually detected by the stethoscope low down on the side of the abdomen, after the fourth month. The sound is caused by the blood circulating through the uterus and placenta, and corresponds to the maternal pulse.

7. *The funic souffle* is said to be recognizable when the cord comes between the fœtal head and the wall of the uterus.

8. The movements of the fœtus can at times be *heard*, splashing about in the amniotic fluid.

9. The movements of the fœtus can be sometimes *seen*, by inspection of the wall of the abdomen.

10. The movements of the fœtus can usually be *felt*, by putting a cold hand on the fundus of the uterus.

Disorders of Pregnancy.—1. *Vomiting*. When morning sickness becomes excessive, and vomiting recurs every time the patient attempts to move out of bed, steps must be taken to stop or check it. To obtain this (*a*) keep the patient in bed on light diet, but give as little fluid as possible. (*b*) Should this not succeed, small doses of hydrocyanic acid, or other specific drug, might be tried. (*c*) In the event of the vomiting still continuing, blood-letting, to the extent of eight ounces, may act advantageously. (*d*) When all means fail, and the patient is reduced to an alarming state, premature labour may be induced.

2. *Displacement of the uterus.* (*a*) Retroversion generally arises from a full bladder pushing back the fundus of the uterus, and tilting forwards the os towards the symphysis. This condition must be relieved by emptying the bladder, and inserting a pessary to support the uterus. (*b*) Anteversion, the reverse of the former, as the os is backwards and the fundus forwards, requires a supporting pessary to keep the uterus in its place, after reducing the displacement. (*c*) Anteflexion and (*d*) Retroflexion require like treatment.

3. *Œdema of the lower extremities*, and varicose veins from the pressure of the gravid uterus on the iliac veins, requires simply rest and support by bandaging and mild aperient treatment to relieve the urgent symptoms.

4. *Hæmorrhoids*, arising from the same causes as the previous trouble, require to be treated on ordinary surgical principles, with the caution requisite in the pregnant state.

5. *Cramps in the legs*, from pressure on the sacral plexus of nerves by the gravid uterus, may be relieved by friction over the painful part, or by using an elastic stocking.

6. *Pruritus of the vulva* is at times intense, and has to be combated by bromide of potassium internally and by lead lotion externally.

7. *Dropsy of the amnion.*—By this is meant a hypersecretion of the amniotic fluid, causing distension of the uterus and a pendulous belly. It is dangerous from the probability of post-partum hæmorrhage occurring, owing to the non-contraction of the uterus. Active measures must be taken to obviate its baneful effects, such as rupturing the membranes early in the labour, and obtain contraction of the distended uterus by some of the ordinary methods.

8. *Epileptiform seizures* (*eclampsia*) are occasional, but when they occur seriously complicate the pregnant state. They may be purely hysterical and require the ordinary hysterical treatment, or they may be more like true epilepsy. They may occur during pregnancy or labour, or in the puerperal period. The cause of eclampsia is apparently some disorder of the kidney, as albuminuria dropsy and uræmic blood-poisoning are almost invariably present. The treatment must be directed first, to allaying the convulsive seizure; and then to the general condition. To allay convulsions, blood-letting may be employed if the patient is plethoric; but if urœmia prevails the inhalation of chloroform is the best method. In all cases the bowels should be well opened; and should convulsions become frequent, the head must be shaved and ice applied, with flying mustard poultices to the lower extremities. Drugs, such as opium, chloral, and belladonna, have been administered for eclampsia with variable success.

9. *Digestive troubles,* such as toothache, heartburn, constipation and diarrhœa, must be relieved, but no violent means are to be employed. A mild aperient occasionally, is by far the best remedy for all such conditions.

10. *Respiratory and cardiac troubles,* such as violent cough and palpitation, are to be relieved in the ordinary way.

Miscarriage or Abortion, and Premature Labour.—Abortion is said to occur when the uterus expels the fœtus before the seventh month. Premature labour signifies the expulsion of the fœtus before the full term, but after the seventh month.

The *causes* of these disorders are:—

I. *Fœtal.*—These may be resident in the fœtus itself, or in the surroundings; the death of the *fœtus;* hydatid degeneration of the *chorion;* abnormal condition of the *umbilical cord,* such as the formation of a twist or knot; *hœmorrhage* between the uterus and placenta;

morbid conditions of the *placenta*, such as inflammation, degeneration, &c.; excess of *amniotic* fluid; any one of these may be sufficient to give rise to expulsion of the fœtus before the full time.

II. *Maternal.*—The causes of expulsion before the full time on the part of the mother are:—

1. *Local.*—These may be *displacements* of the uterus; diseased condition of the *deciduæ; tumours* of the uterus; tumours or inflammation in *neighbouring organs;* and violence.

2. *General.*—Any departure from the healthy state may act as a cause—anæmia, plethora, syphilis, acute specific fevers, strong mental emotions, jolting, over-exertion, and the use of violent purgatives; a strong emmenagogue, such as the ergot of rye.

The *symptoms* of abortion are *pain* of an expulsive character and *hæmorrhage.*

Treatment.—1. When it is hoped, from the mildness of the symptoms, that abortion may be *prevented,* the first thing to be done is to put the patient to *bed,* and keep her cool. The *diet* must be light, non-alcoholic and cold. The *drugs* that produce the best effect are—opiates, alone or combined with dilute sulphuric acid; ergot of rye, in small doses; or the injection hypodermically of morphia or ergotin. 2. When preventive measures are useless, then *active interference, to help the uterus in its expulsion,* is necessary. When the *hæmorrhage is profuse,* repeated and large doses of ergot may suffice; but if not, plugging of the vagina must be resorted to. When all means fail, the dilatation of the cervix by a sponge-tent will arrest the hæmorrhage, and allow readily of the expulsion of the contents. To ensure the *complete evacuation* of the contents, insert two fingers into the cavity of the uterus, and scoop out all the contents. This process is much more readily gone through if the patient is under an anæsthetic. When the *uterus is emptied,* the patient must be treated as an ordinary puerperal case.

The Duration of Pregnancy.—It is generally agreed that 280 days, dating from the last menstruation, is the normal time at which to expect labour. Parturition will, in all probability, occur within a week of this time.

Natural Labour.—The *premonitory symptoms* are:—

1. Contractions of the uterus, which may be felt by the hand, but are not accompanied by pain.

2. Irritability of the bladder.

3. Irritability of the rectum.

4. A change in the shape and position of the uterus.

5. The show—*i.e.*, a slight mucous discharge, mixed with blood, from the vagina.

Natural labour consists of *three stages* :—

I. *The First Stage of Labour* commences from the time at which *true uterine* pains set in until the *full dilatation of the os and rupture of the membranes.*

1. The pains, at first slight with long intervals, get more frequent and pronounced. The pains are of a *cutting* or *grinding* nature in this stage.

2. The uterus becomes hard and tense beneath the hand during the pains.

3. The os uteri, at first high up, comes lower down as the uterus sinks.

4. Rigors are not unfrequent concomitants in this stage, owing to the dilatation of the os.

5. Vomiting of food from the stomach is not an unfrequent occurrence.

6. The membranes present as a tense swelling during the pain, but become soft and fluctuating between the pains.

7. The os uteri becomes fully dilated.

8. The membranes are ruptured, and the liquor amnii escapes.*

II. *The Second Stage of Labour* :—

1. The uterine pains become more frequent, more powerful, last much longer, and have a *bearing down* character.

2. The uterus sinks lower down, and the head gradually passes through the os.

3. The vagina and uterus form a continuous passage.

4. The head enters the vagina.

5. The head distends the perinæum.

6. The head now takes a direction forwards, and appears at the vulva.

7. The head is born.

8. The body, after undergoing the motion of restitution, passes through the vulva, and the child is born.

III. *The Third Stage of Labour.*—This is the period that intervenes between the birth of the child and the birth of the placenta.

* Some authors put No. 8 with the second stage.

1. After the child is born there is a lull in the process, and the uterine pains cease for a time.

2. During this period the liquor amnii gradually escapes, and blood flows away in greater or less quantity.

3. A sharp uterine contraction occurs, unaccompanied by voluntary efforts.

4. The placenta is expelled from the cavity of the uterus and lies in the vagina. It may escape from the vagina of itself, or require to be taken out by the hand.

THE MANAGEMENT OF NATURAL LABOUR. — I. The medical attendant should go immediately when called.

II. When he comes into the room he should talk to the nurse and watch the patient.

III. The patient should be encouraged, spoken to kindly, and made to walk about.

IV. The first pain should be noted, and the character of the pain, whether spurious or true, observed.

V. When the next pain comes on, a *vaginal examination* should be made. To make a vaginal examination, place the patient in a recumbent posture, on her left side. After greasing the fingers with a disinfectant—such as carbolic soap or boracic ointment—introduce the forefinger of the right or left hand into the vagina, and examine the os uteri. It must be remembered that the os points backwards, towards the sacrum, at the commencement of labour, and that the part the beginner will feel, and get confused over, is the anterior lip of the uterus. Hence, take care to dig the finger in beneath the anterior lip of the os and turn the point upwards. The *points to be made out* by a vaginal examination are :—

1. The condition of the vagina.
2. The state of the os and the stage of the labour.
3. The position of the uterus.
4. The presentation—*i.e.*, the part of the child presenting.
5. The condition of the pelvis.
6. The state of the bladder and rectum and surrounding parts.

VI. When the examination is over, encourage the patient to walk about; and see that the nurse has everything ready—such as thread or twine, scissors, and a binder.

VII. During the first stage of labour, the medical attendant need not remain in the room all the time.

VIII. When the second stage of labour commences, the medical attendant must be present in the room the whole time.

IX. Frequent vaginal examinations must be made to see that the labour is progressing favourably.

X. When the head is distending the perinæum, no good can come of violent support; but gentle support with a napkin, by placing the hand, covered by a napkin, over the anus and its neighbourhood, may prevent extensive perineal laceration.

XI. When the child's head is born, examine to see whether or not the cord is round its neck. If it is, remove it as quickly as possible.

XII. When the child is born, tie the cord twice about two and three inches from the umbilicus, and cut between the ligatures.

XIII. Hand the child over to the nurse, and apply gentle pressure by the hand over the uterus, or grasp the uterus gently, to cause it to contract and expel the placenta.

XIV. Should the placenta show no sign of separation at the end of twenty minutes, and pulsation still exist in the cord, and especially if hæmorrhage is present, steps must be taken for its removal. Slight traction is permissible only to ascertain whether the placenta is loose or not. But for further treatment, *see* "Post-partum Hæmorrhage."

THE DIMENSIONS OF THE PELVIS have been ascertained at the inlet or brim, the cavity, and the outlet of the pelvis.

The *inlet* presents four diameters—a *transverse, antero-posterior*, and *two oblique*. The names transverse and antero-posterior explain themselves; but the obliques are right and left. In each case the sacro-iliac synchondrosis is taken as the starting-point, and a line is drawn hence to the opposite pectineal eminence or acetabulum; hence the diameter which passes from the right sacro-iliac sychondrosis to the left pectineal eminence is called the right oblique diameter, and *vice versâ* with the left side. In like manner, we have four diameters to the cavity and outlet. In one or other of these diameters of the inlet the child enters previous to its birth; and by a process of rotation, passes down through the bony pelvis.

The part of the child which naturally presents is the

head, and it may enter in any one of the four diameters. The most common diameter for the head to enter is the *right* oblique, with the back of the head forwards—*i.e.*, the child's head will be in a line drawn from the right sacro-iliac synchondrosis to the left pectineal eminence, with the back of its head towards the left acetabulum, and its face towards the right sacro-iliac synchondrosis. This is called the *first position, and it is the most common.* In the *second position*, the head is in the *left* oblique diameter, with the occiput towards the right acetabulum. In the *third position*, which is the *second most common*, the head is in the *right* oblique diameter, with the occiput at the sacro-iliac synchondrosis. In the *fourth position*, the head is in the *left* oblique diameter, with the occiput at the synchondrosis. It will be seen then that the head occupies most frequently either the *first* or *third* position, and they are both in the *right* oblique diameter; one with the occiput forwards, the other with the occiput backwards.

Presentation of the Head.—To follow a natural labour, and the mechanism involved in it, the following details have to be studied. The brim of the pelvis we shall divide into $\frac{8}{8}$ths, and with a pelvis before the reader, the following will be made out:—$\frac{1}{8}$th of the brim from the symphysis to the pectineal eminence; $\frac{1}{8}$th from hence to halfway along brim of pelvis; $\frac{1}{8}$th hence to sacro-iliac synchondrosis; and the remaining or fourth $\frac{1}{8}$th from hence to the middle of the first piece of the sacrum. As the two sides are the same, it is seen there are $\frac{8}{8}$ths described. Now to follow the mechanism of parturition, we shall imagine a natural first presentation. The part to be felt through the os is the *right parietal eminence.*

1. There is *general flexion* of the child, owing to the uterus contracting on the child's body.

2. *Descent* into the pelvis.

3. *Internal rotation for $\frac{1}{8}$th of the circle of the inlet*—*i.e.*, the occiput, which is towards the left pectineal eminence, moves round to get below the symphysis, and as before shown this occupies $\frac{1}{8}$th of the brim.

4. *Extension of the chin from the chest and the birth of the head.*—The occiput being beneath the symphysis, the face sweeps over the sacrum, and the chin leaves, or is extended from, the chest.

5. *External rotation of the head and internal rotation of the body*, the motion of restitution—*i.e.*, the head being

born, turns, so as to bring the child's face towards the right thigh of the mother; and the body, being inside the pelvic cavity, turns, so to get the right shoulder beneath the symphysis. Notice particularly, that the terms outside and inside only refer to the fact that the head is outside (external rotation), whilst the body turns within the cavity (internal rotation).

6. The *right shoulder now catches on the symphysis*, the *left shoulder sweeps over the sacrum, and the child is born.* The modifications of the details of this mechanism to suit the other positions are easy. Imagine the head in the *third position*—*i.e.*, with the back of the head at the right sacro-iliac synchondrosis—the same description obtains, except that instead of the rotating $\frac{1}{8}$th of the circle of the brim (*see* 3), it rotates $\frac{3}{8}$ths of the brim, the occiput passing from the right sacro-iliac synchondrosis forwards to beneath the symphysis, which, as already explained, forms $\frac{3}{8}$ths of the brim.

Face Presentations.—There are four face presentations, corresponding to the four positions given for natural labour, when the vault of the cranium presents.

I. The most common face presentation is when the head lies in the right oblique diameter. In this case the forehead is at the left obturator foramen, and the chin at the right sacro-iliac synchondrosis. The same steps are gone through as in natural labour:—

1. General flexion.
2. Descent into the pelvis.
3. Internal rotation, the *chin* sweeping round for $\frac{3}{8}$ths of a circle to get in below the symphysis.
4. Extension of the occiput from the back, *i.e.*, flexion of the chin on the chest, brings the head out; the occiput sweeping the sacrum, the chin being at the symphysis.
5. The movement of restitution, as with the vault presentation.
6. Birth of the body.

II. The second position is the second most common face presentation—*i.e.*, the head lies in the left oblique diameter, with the forehead at the right obturator foramen and the chin at the left sacro-iliac synchondrosis. The same steps are gone through as before, the chin sweeping round along the left wall of the pelvis for $\frac{3}{8}$ths of a circle, so as to come from the left sacro-iliac synchondrosis to the symphysis pubes. The *diagnosis* of a face presentation is ascertained thus:—The malar bone

and the cheek of the right side present in the first position and the corresponding part of the left side in the second position. The bridge of the nose in the middle of the face, aids in diagnosing the face from the anus; the mouth, forehead, and eye may be made out, and commencing with an unbiassed opinion in regard to the presentation there need be little difficulty in diagnosis.

Breech Presentations. — Comprehended in the term breech presentation, are all presentations of the lower part of the body, be it the nates or the feet. The positions in which the child may enter the pelvis are the oblique diameters with the front of the body, looking backwards or forwards. The *first* position, and the most common, is when the child's hips enter in the left oblique diameter, with the child's abdomen looking to the right side of the mother, with the child's left ischium at the right obturator foramen, and the right ischium at the left sacro-iliac synchondrosis. The same steps are gone through as in natural labour.

1. General flexion.
2. Descent
3. Internal rotation, in this case of the hips, for $\frac{1}{8}$th of a circle, so that the child's left hip passes in beneath the symphysis pubes.
4. The body is now bent, and first the nates and lower limbs, and then the body and upper limbs, are born; the abdomen looking towards the right thigh of the mother.
5. The body externally, and the head internally, now undergo the motion of *restitution*, so that the child's back turns upwards, and the back of its neck lies beneath the symphysis, whilst its face lies in the hollow of the sacrum.
6. The face now sweeps across the hollow of the sacrum—*i.e.*, becomes flexed on the chest, and so the child is born.

In the *second* most common position the child lies in the right oblique diameter, and the same processes of evolution are gone through, only that, when the child is born, the abdomen looking towards the left thigh of the mother.

The *diagnosis* of a breech is to be made out by the rounded hips, the anus, and the coccyx; in front the genitals, and on either side the tuberosities of the ischia. In regard to the *treatment* when the delivery is advancing naturally, avoid pulling on the protruding part of the child, unless exhaustion is pronounced.

Transverse Presentations.—This comprehends arm, shoulder, and body presentations. In the *first* most common position the right arm protrudes, the child's head lies in the right iliac fossa, and its nates in the left iliac fossa; the abdomen of the child is forwards. In the *second* most common position, the right arm protrudes, the head lies in the left, and the nates in the right, iliac fossa, and the back of the child is forwards. The same positions may occur with the left arm protruding, but they are extremely rare. The body may be born in this position by *spontaneous evolution*, but turning in almost all cases is necessary. The *diagnosis* of this presentation is by the hand, elbow, or shoulder. The shoulder and ribs are to be felt with their characteristic bony prominences, the position of the palm of the hand will also help in diagnosis.

Lingering Labour and the Obstruction to Natural Labour.—This subject is best discussed by considering the obstructions according to their seat:—

A. Obstruction due to some abnormality of the *child* may be some one or more of the following:—

1. *Malpresentations.* When any presentation other than the head exists the labour will be delayed.

2. *Deformities of the child.* (*a*) Hydrocephalic head; (*b*) tumours of the chest or abdomen; (*c*) excessive size of the child; (*d*) monstrosities, such as union between two children. The shape of the head may be such as to present a difficulty in entering the pelvic brim; it may be too long from before backwards (*dolichocephalic*), or it may be contracted in length, but of an excessive width (*brachicephalic*).

B. Obstruction may be due to the *cord* or *membranes*.

1. The *cord* may be too short or too long, or twisted round the child's neck.

2. The *membranes* may *give way early*, and as a consequence the os is slower in dilating; or again, the membranes may be excessively *tough* and so delay labour.

Treatment.—That the abnormalities of the cord can give rise to obstruction is in the majority of cases fanciful. When the membranes are ruptured early, give opium, and wait for full dilatation; when they are tough, rupture them by cutting a notch or two in a fingernail and saw through the projecting membranes.

C. Obstruction may be due to changes in the *uterus*; these may be owing to—

1. Feeble and irregular action of the uterus; this may be overcome by the administration of moderate doses of ergot of rye, say half a drachm or a drachm of the liquid extract of ergot, every half-hour until a beneficial effect is produced. It is nauseous, but easily disguised in tea or coffee. The indications for giving it are—1, feeble and inefficient pains, without especial cause; 2, if the os uteri be soft and dilatable; 3, if there be no obstacle to a natural delivery; 4, if the head or breech present, and are pretty well advanced; and 5, if there be no head symptoms, nor excessive general irritability. But, on the other hand, it should not be given—1, if the os uteri be hard and rigid; 2, if the presentation be beyond reach; 3, if there be a mal-presentation; 4, if the pelvis be deformed; 5, if there be any serious obstacle to delivery in the soft part; and 6, if there be head symptoms, or much general irritation.

2. Cicatrices of the os uteri, the result of laceration in former labours. To treat this condition after "time" has had a fair chance, give opiates to gain time, lubricate the parts with lard; but if nothing answers, the os must be *nicked* with the edge of a bistoury, in three or four places, whilst it is on the stretch over the child's head.

3. Carcinoma of the os uteri is to be treated in much the same way as the former; so also—

4. Rigidity of the os.

5. A uterine polypus obstructing labour must be either pushed out of the way or removed.

6. Displacements of the uterus. In these cases the os is directed backwards, forwards, or laterally, according to the nature of the displacement. Mechanical manipulation will generally get rid of the difficulty, provided no permanent affection of the bones is the cause.

7. Abnormal distension of the uterus from excess of liquor amnii. When diagnosed early, rupture of the membranes will reduce the evil effects.

D. Obstruction may be due to affections of the *vagina* or *perinœum*.

1. Cicatrices from previous labours.

2. Imperforate hymen.

3. Extravasation of blood into the labia, varicose veins, and œdematous swellings are not unfrequent complications.

Treatment.—If varicose veins bleed excessively, labour

must be hastened; extravasation is best treated by cold applications.

E. Obstruction may be due to numerous causes that are *extra-genital—i.e.*, in the surroundings.

I. Deformed pelvis.

1. The pelvis may be *well formed*, but may be abnormally *large* or abnormally *small*. In the latter condition it may be *masculine*, too *feminine*, or *puerile*.

2. It may be *contracted* in one or other of the following ways—

(*a*) Antero-posterior contracted pelvis; this is the commonest form, and is due to rickets.

(*b*) Transversely contracted pelvis may be of two kinds: 1. Owing to anchylosis of *both* sacro-iliac sychondroses, called *Roberts's* contracted pelvis, or the *ilio-sacral synostotic pelvis*. 2. Owing to anchylosis of *one* sacro-iliac synchondrosis, called Naegele's pelvis, or the *obliquely contracted pelvis*. In Roberts's pelvis, the contraction renders the pelvis oval, in Naegele's, obliquely oval or triangular.

(*c*) The funnel-shaped pelvis, wide above and narrow below.

(*d*) The collapsed pelvis may be due—1, to *Rickets;* in which case the pelvis is flattened from before backwards and wide in its transverse diameter; 2, to *Mollities ossium*. The first change in shape from mollities is the pushing in of the sides of the pelvis, owing to the weight of the body on the top of the thigh-bones. Then the sacrum and coccyx are bent in; the rami of the pubes meet before the symphysis, and the symphysis itself is bent backwards or forwards.

(*e*) The pelvis may be contracted from growths from its walls; these may be bony, fibrous, sarcomatous, &c.

The *diagnosis* of deformed pelvis is difficult; careful inquiry into the *history* of the patient, with the object of ascertaining whether any *injuries* had been received; whether *hip-joint* or *sacro-iliac disease* had ever existed; or whether rickets is likely to be the cause. When no deformity is apparent in the pelvis, the limbs, especially the thighs, should be examined; and when a *short femur* is present, then there is likely a deformity of the pelvis.

To MEASURE THE PELVIS two methods are adopted, either *external pelvimetry* or *internal pelvimetry*. External pelvimetry is useless except in the obliquely contracted, Naegele's pelvis; in which measurements between the ordinary salient points of the pelvis will show a difference

in the two sides. Internal pelvimetry may be done by instruments, but it is best done by the finger.

Treatment.—Mollities ossium offers little or no obstruction, as the softened bone expands before the descending child. When, however, other conditions obtain the following rules are to be followed :—

1. When the shortest diameter is not less than $3\frac{1}{4}$ inches, *forceps* is to be used.

2. When the shortest is from $1\frac{1}{2}$ to 3 inches, when turning fails, *embryulcia* is to be performed.

3. When the shortest diameter is not more than $1\frac{1}{2}$ inches, *Cœsarian section* must be performed if the life of the child is to be saved; or *abortion* must be induced before the middle period of pregnancy.

4. When the shortest diameter is from $2\frac{3}{4}$ to $3\frac{1}{2}$ inches, if premature labour has not been induced, it is usually possible to deliver at the full time by turning.

II. Deformities may exist in the bones *adjacent* to the pelvis, and chiefly in the lumbar vertebræ.

1. The sacral vertebræ may curve sharply backwards to such an extent as to prevent the child's head following the natural course, constituting the *lumbo-sacral cyphotic pelvis;* or anchylosis may exist between the fifth lumbar vertebra and the sacrum—*lumbo-sacral synostotic pelvis.*

2. The fifth lumbar vertebra may slip forwards, overhanging the sacrum for a short distance; this deformity, which goes by the name of the *spondylolysthetic pelvis,* must evidently obstruct the brim. The rules for the treatment of this group of deformities is the same as for deformed pelvis.

III. Obstructions may arise from tumours of the *ovaries* and *Fallopian tubes.* The nature of these is arrived at, from the fact that they are usually movable: and that they, when cystic in nature, fluctuate and become tense during a pain.

Treatment.—1. Clean out the bowels and bladder; 2, try and push the tumour above the brim; 3, if impossible, wait to see what Nature does; 4, when Nature is incapable of overcoming the obstacle, use forceps; 5, should forceps fail, puncture the tumour with a trocar; 6, should all these fail, perform embryulcia or Cæsarian section.

III. Obstruction may exist from *vaginal enterocele.* Examine with the finger, make out impulse in coughing, and reduce.

IV. Fæcal accumulation in the *rectum* may be a cause of obstruction to labour. This can be removed by enemata or by scooping out the mass of fæces.

V. Bladder affections are frequent causes of obstruction in one or other of the following ways:—

1. Distensions, causing diminution in the brim, checking the contraction of the uterus and the muscles of the abdominal wall. To treat this pass a *catheter*—a male gum elastic is best. Should it be impossible to pass a catheter, put on *forceps;* there is little fear of causing rupture of the bladder.

2. When the bladder is displaced, and carried down before the head, pass a *catheter;* if impossible use *forceps*, but be careful not to apply too much force, owing to the danger of rupturing the bladder. Should these fail, tap with a very fine trocar through the vagina.

3. A calculus in the bladder may obstruct labour.

Treatment.—Push the calculus up if possible; if not, use *forceps;* if likely to lead to bad results, do *lithectasy* or *lithotrity*, or if necessary *vaginal lithotomy*.

VI. Tumours of the cellular tissue of the pelvis may obstruct labour. These may be inflammatory, fatty, fibrous, cystic or cancerous. These are diagnosed chiefly by their *fixity* as compared with the movable ovarian tumours.

The *treatment* consists in aiding Nature with oils and ointments; compressing the tumour with the fingers and pushing it away; or, as these means are likely unavailable, apply forceps, remove the tumour, or perform Cæsarian section.

HÆMORRHAGE consequent on child-bearing may be one or other of the following:—

A. Unavoidable hæmorrhage occurs when there is malposition of the placenta, so that it comes to be implanted over the os—called placenta prævia, or placental presentation. The hæmorrhage comes on any time after the sixth month; the earlier it comes on the more grave is the prognosis. The part from which the blood flows is the line of junction between the placenta and the uterus, where the vessels are partially torn through.

The *symptoms* are general signs of bloodlessness, with blood escaping externally.

The *diagnosis* has to be made by digital examination, by which method the placenta can be felt lying over the os uteri. The only mistake that is apt to arise is taking

the placenta for a blood-clot or a cauliflower excrescence around the os. The stringy, spongy feel of the placenta will, however, determine the diagnosis.

The *prognosis* is grave. Of the mothers the proportion of deaths is 1 to $3\frac{1}{2}$, of the fœtus 2 in 3.

Treatment.—I. Palliative :—

1. Recumbent position.
2. Pure air.
3. A cool room.
4. Light cold diet.
5. Astringent acids, such as tannic and gallic acids, to be given internally.

II. Local hæmostatics :—

1. Apply astringents, as alum, tannin, perchloride of iron mixed with glycerine, to the part. This is not much good, as it is difficult to get at the bleeding spots exactly.
2. Plugging the vagina.
3. Separation of the placenta may be complete or partial. The latter may be done by passing one finger along the line of union of the placenta and uterus, and tearing only the line of union. It may stop temporarily the hæmorrhage, and thus allow time to be gained.

III. Hasten delivery: one would be prompted to do so when—

1. There has been much blood lost.
2. When the constitutional symptoms of anæmia are marked.
3. If the cervix is soft and dilatable.

The *methods by which labour is hastened* are—

1. Rupturing the membranes by the finger, catheter, trocar, or sharpened quill.
2. Dilating os with finger or bags.
3. Turning.

Should this fail—

4. Use forceps.

Should this fail—

5. Perform embryulcia.

To sum up these various methods to treat any one case of placenta prævia—

I. If labour has *not* commenced, or if the consequences are not severe, induce labour.

II. When labour *has* commenced :—

1. When hæmorrhage *slight*, use palliative measures, and if the pains are no use give *opium*.
2. When hæmorrhage is *severe*.

(*a*) Deliver by *turning*, if the os is or can be dilated.

(*b*) If the os cannot be dilated, then *puncture the membranes* if within reach; if not, plug the vagina.

(*c*) When hæmorrhage continues even after trying these, and supposing the child dead and turning not possible, separate the placenta by passing the finger along the line of union of the placenta and uterus; or if that will not stop hæmorrhage, separate the placenta completely.

(*d*) Should the life of the mother be in danger, deliver at all hazards, and in five minutes if possible, by putting one's hand into the os as a cone, and seizing the child's foot.

B. Accidental hæmorrhage. This may occur *before and during labour. It depends on a separation of some part of the placenta.*

The *causes* are—

1. External violence.
2. Violent uterine action during labour.
3. Excessively tough membranes.

When the blood escapes externally it will be noticed that the blood escapes *during the intervals* between the pains, and ceases during the pains. The *diagnosis* has to be made from placenta prævia, and that is easily done by examination with the finger, by which means the presence or absence of the placenta at the os at once settles the question. When *no* blood escapes externally the diagnosis has to be made by *constitutional* symptoms of loss of blood.

Treatment.—1. If hæmorrhage slight, use *palliative measures*, and *apply pressure* by a bandage, especially if the full time has not arrived.

2. If the hæmorrhage is severe, *rupture* the membranes and give ergot.

3. If these fail, and the hæmorrhage very severe, and the passages permit, *turn*.

4. If there is great danger, incision of the os and cervix if necessary, and *deliver at all hazards*, by embryotomy or otherwise.

C. Post-partum hæmorrhage—*i.e.*, hæmorrhage coming on after the birth of the child. This condition is induced either through—

1. The placenta remaining attached in whole or part and preventing the uterus contracting properly.

2. The placenta may have been expelled, and owing to atony of the walls the uterus does not contract. This

condition may arise from multiparity, from tedious labour; from great distension, twins, triplets, or hydramnios.

The blood escapes either with a gush or in clots.

Treatment.—1. Should previous knowledge of the patient in labour cause fears that hæmorrhage is likely to occur, give ergot of rye when the child is being born; and press on the uterus with both hands.

2. When the hæmorrhage goes on, get away the placenta—(*a*) by kneading the uterus, with slight traction on the cord; (*b*) or extract the placenta by introducing the hand and forcibly tearing it off the wall, at the same time give ergot of rye to help the uterine contractions. Should the hæmorrhage not recur, give opium and stimulants if the patient is very faint.

PUERPERAL FEVER is a continued fever, arising from septic poisoning, and occurring shortly after childbirth. Lesions of the vagina or uterus or retained pieces of placenta are found in connection with the disease, and septic organisms infect either a torn part or the surface of the uterus. Puerperal fever occurs epidemically or endemically. It is spread chiefly by *contagion;* any filth on the hands of the nurse, or on the sponges, &c., used. The medical practitioner may carry it on his hands, especially had he been touching post-mortem material; again, had he been in the presence of others suffering from erysipelas, scarlet fever, or any infectious fever there is a possibility of his setting up puerperal fever by his attendance at a labour. The symptoms are generally ushered in with a rigor, three or four days after delivery. The usual symptoms of fever ensue:—a rapid feeble pulse; the temperature 103° or more; a dry skin; tongue becomes coated, then hard and dry; vomiting of coffee-ground material; tenderness and pain in the abdomen; and frequently diarrhœa. The mammæ cease secreting and become tense and painful; the lochia are suppressed. Finally, a typhoid state sets in, and pneumonia and secondary abscesses may precede the death of the patient. The disease when it ends fatally does so within a week. Frequently the very worst forms recover.

Treatment.—Scrupulous cleanliness, and the avoidance of every possible means of conveying septic material. Everything that touches the patient should be thoroughly antiseptized. Sponges, and the nurse's and the medical practitioner's hands, should be rinsed in a solution of 1 in 20 of carbolic acid. The lard used should also be anti-

septic, containing carbolic acid. The *general* treatment is to be confined to fresh air, simple diet, brandy, the washing out the uterus and vagina with an antiseptic fluid. Pain may be relieved by hot flannels and opiates or belladonna, &c., over the abdomen. Opium may be given internally to relieve pain, &c. Turpentine, quinine, aconite, salicylic acid, &c., have all been pronounced as efficient remedial means.

Eclampsia has been discussed previously.

Puerperal Mania.—May develop itself any time from the beginning of pregnancy to the end of lactation; but it is usual to limit the term during which it occurs to three weeks after delivery. The *causes* are debility, mental excitement, rapidly following pregnancies, very young mothers, women having their first labour when advanced in years, &c.

The *symptoms* follow either a melancholic or suicidal form. The patient may, about a week or ten days after labour, become restless, sleepless, feverish, and excited. The features express alarm, suspicion, or ferocity. The patient may be taciturn or talkative, more frequently the latter, and the speech may be incoherent. This condition has to be *diagnosed* from puerperal fever and pyæmia. In both of these conditions the delirium may come on, but the feverish symptoms always precede, whereas in puerperal mania they *follow*, the mania. About 70 per cent. of the cases *recover*; mostly during the first six months. When the mania lasts more than twelve months there is little hope of recovery.

Treatment.—All sources of irritation must be removed, and the patient's strength restored. The bowels should be cleared out; the condition of the bladder attended to; the lochia should be encouraged by injecting warm water. Rest must be obtained by darkening the room, deadening noise, removing the child, and allowing strangers to attend on the patient. Chloral is the best hypnotic, in doses of about thirty grains. When the disease becomes chronic, the usual means for restoring appetite and overcoming anæmia and debility are to be pursued.

OBSTETRIC OPERATIONS.

I. To induce abortion. When the pelvic diameter is known to be below $1\frac{3}{4}$ inches, or when tumours are known to obstruct the pelvic passages, or when albumi-

nuria and vomiting are pronounced and dangerous, it is desirable to bring away the fœtus before the seventh month, and it may be much earlier. The plan of procedure is to rupture the membranes and dilate the os with a sponge-tent.

II. To induce premature labour. The cases in which it is advisable to deliver before the full time, are—

1. When the shortest pelvic diameter measures $2\frac{3}{4}$–$3\frac{1}{2}$ inches; if the diameter is less than that the child cannot live; if more, but still below normal, it may be delivered by forceps at the full time.

2. When tumours diminish the pelvic passages.

3. When vomiting; uræmic convulsions; accidental hæmorrhage; diseases of thoracic viscera, as phthisis, &c.; and abdominal tumours, as ascites, affect the *mother*, then induce labour, when the ordinary methods of treatment fail.

4. When the *fœtus* seems likely to die, or is dead.

5. When the fœtus is very large.

6. When it is known that great trouble had existed previously, when the mother was allowed to go on to the full time.

The methods in use are—Friction over the uterus; ergot of rye; the douche; the injection of cold water, carbonic acid or air into the uterus; dilatation of vagina or uterus, &c. These are all uncertain. *Two* methods may be tried with good hopes of success :—

1. Insert a gum elastic catheter between the membrane and the uterus, push it on until it has gone as far as it can. Allow it to remain for eight hours, and within twenty-four hours expect labour to come on. Should this fail—

2. Dilate the cervix uteri with finger, or sponge-tents, or caoutchouc bags.

The patient should be treated as after a labour at the full time.

III. Turning or version. There are two kinds—namely, cephalic or podalic version.

Practically, the *podalic* is the only one worth discussing. The cases in which it should be done are—

1. In transverse presentations.

2. In cases where the forceps is not applicable, and where there is danger to the *mother* from hæmorrhage, &c., and where speedy delivery is required.

3. Where there exist complications dangerous to the *child*, as prolapse of the cord, &c.

4. When the head refuses to enter the pelvis.
5. In prolapse of the limbs with the head.
6. When the shortest pelvic diameter is $2\frac{3}{4}$ to $3\frac{1}{2}$ inches; this being too narrow for forceps.
7. When the child's head is larger than normal.
8. When the mother dies before the labour is over.

Method of operating—

1. Ascertain how the child lies.
2. Use the hand that can most easily pass over the front of the child.
3. Place the other hand over the fundus of the uterus to prevent it receding.
4. Grease the back of the hand and introduce it in the form of a cone into the vagina during a pain, if labour has commenced.
5. When the pain is over, introduce the fingers slowly through the os and dilate.
6. Keep the hand always in the axis of the pelvis.
7. If the membranes are entire, rupture near the os.
8. Advance the hand along the anterior aspect of the child.
9. Keep the hand close on the fœtus, and beware of the knuckles rupturing the uterus.
10. Desist when a pain comes, and lay the hand out flat.

To extract the child—

1. Seize by preference both knees; if only one can be seized, the farther off is the better.
2. Pull the part down by continuous gentle traction.
3. Bring the part down over the front of the child.
4. Stop proceedings when a pain comes on.
5. When the breech is in the pelvis leave the child to Nature.

IV. The Forceps.—Here the long forceps will be chiefly discussed.

The indications for the use of forceps, are—

1. When the *maternal* passages are too small. Should the passages be not smaller than $3\frac{1}{2}$ inches, the forceps will compress the child's head sufficiently to allow of delivery.
2. When the head of the *child* is too large; when there is malposition; or when the sutures of the fœtal skull have become ossified.
3. When there is danger to the mother or child from hæmorrhage, convulsions, rupture of the uterus, or prolapse of the cord.

4. Where the expulsive force of uterus is insufficient; and where accessory muscles are wanting in action.

The forceps *acts* thus—

1. By direct traction.
2. By compressing the child's head $\frac{1}{2}$ to 1 inch in diameter, and moulding the head to the shape of the passages.
3. By lateral motion, acting as a lever with slight side-to-side motion.
4. By rectifying and improving the position of the child's head.

The preliminaries to the use of the forceps should be—

1. To tell the mother.
2. To see that the passages are in a proper state.
3. Have the bladder and rectum emptied.
4. Have the patient across the bed, either on her left side or her back, with the nates over the *edge* of the bed.
5. Warm the blades and grease their outsides.
6. Find out the exact position of the head of the child.

Introduction and application of the forceps—

1. Select a blade for entrance. Supposing the patient on her left side, lock the blades in front of the body, keep the curvature towards the pubes, and choose the blade which is lowermost—*i.e.*, the right blade.
2. Put the left hand into the vagina during a pain, and make out the presentation, rupturing the membranes, if they have not previously given way.
3. Grasp the handle of the blade chosen in the right hand, guide the blade gently along the hollow of the left hand until it reaches the fœtal head. Do this between the pains.
4. Keep the blade persistently in the left oblique diameter, and pass it upwards to the left of the pelvis over the left side of the child's head.
5. Keep the tip close to the head, and stop when a pain comes on.
6. Use gentle pressure ; should a difficulty occur, withdraw the blade a little, and push it up in a slightly different direction.
7. When the blade is fully introduced, push the handle towards the perineum, so as to allow of the introduction of the second. Give the handle to an assistant to hold, or if one can hold it in position, between the thumb and two last fingers, leaving the second and third fingers free to direct the other blade.

8. Introduce the second—*i.e.*, the uppermost—blade, with the point above to the right and the handle downwards. Raise the handle gently, and the blade will slip over the right side of the child's head. The right hand is usually used as the guide for the second blade.

9. When both blades are introduced, press the handles together, and lock them.

10. Should the head be low down, pass the blades of the forceps along either side of the head, as it happens to be lying.

The extraction by forceps:—

1. Do not act continuously.
2. Pull directly with a slight side-to-side motion.
3. Whilst pulling compress the blades firmly.
4. Pull the head along the axis of the part it is in.
5. See that the head undergoes the right evolution.
6. If the head refuses to come down, push it up a little.
7. Withdraw the blades when the head is nearly born.
8. Protect the cervix and vagina being injured by the forceps, head or shoulders.

V. The Lever or Vectis resembles a single blade of the forceps; it is used to rectify the position of the head.

VI. The Blunt Hook is used to pull down a breech presentation by hooking over the groin, or to hold the neck for decapitation.

VII. The Fillet or Loop is simply a loop of whalebone, fitted on a handle; it may be slipped over the occiput or chin, on which traction can be made. It possesses no power of determining the direction of the child.

Cutting operations on the mother and fœtus:—

I. *Symphyseotomy*, called also the Sigaultean-operation, consists in a division of the symphysis pubes. No practical end is gained by this operation.

II. *Cæsarian section*—hysterotomy—is the bringing the fœtus out through the wall of the abdomen.

It is performed—

1. When the shortest pelvic diameter is $1\frac{1}{2}$ inches and under.
2. When the mother is dead and the child alive.
3. When there is advanced cancer of the cervix uteri.

Operation.—The usual steps must be taken as to the preparation of the room, &c. Take a stand, as in ovariotomy, between the legs of the patient, carry an incision from below the umbilicus to the symphysis pubes. Lay bare the uterine wall, cut it through and extract the child, head or feet first. Then remove the placenta, and see that

drainage is provided for through the os uteri. Sew up the wound with catgut. The child will almost certainly be dead in *five* minutes after the death of the mother, but still the operation should be done, although twenty minutes have elapsed.

III. *Craniotomy* or *Embryotomy.*—This operation consists in perforating the head of the fœtus by a *perforator*, and extracting by the *craniotomy forceps.* The *crotchet* and the *vertebral hook* are also accessories to the forceps in promoting extraction. This operation has to be done—

1. If the shortest pelvic diameter is from $1\frac{1}{2}$ to 3 inches, craniotomy will likely be required.

2. When the child's head is too large to pass down; or when from position or locking of parts delivery is stopped.

3. When there is immediate danger to the mother, and turning or forceps are not applicable.

The *perforator* must be introduced carefully, so as not to injure the vagina or uterus; it must be held at right angles to the fœtal head and pushed into the bones, first in one place, then in another. The *crotchet*, or blunt hook, can now be introduced through one of the holes, and traction made. Instead of this, introduce one blade of the *craniotomy forceps*, the cranioclast, through the hole, and placing the other outside, pull the head down. Should the forceps not be sufficient, the *cephalotribe* must be employed. This instrument is introduced in the same way as the forceps, but is used to crush the head; and by changing its position the head can be crushed to a small mass of bone and cerebral *débris.*

IV. *Embryulcia* means the opening the cavity of the chest or of the abdomen, or both, to allow of the escape of the contents. When even after the use of the cephalotribe, and it is impossible for the body to be born, and in many cases of transverse presentation, embryulcia is necessary.

V. *Decapitation* may be performed by a scissors or *sharp hook.* The vertebral column is cut through, and the body can then be drawn down, and the head delivered afterwards by forceps.

Diseases of the Fœtus.—The fœtus is liable to almost the same diseases as are observed after birth. Among the more common are: fracture of the bones of the skull; cerebral hæmorrhages; chronic hydrocephalus; convulsions; pleurisy; pulmonary tuberculosis; acute and chronic peritonitis; diseases of the liver and spleen; worms in

intestine; kidney disease; cardiac inflammatory diseases, and skin affections.

Death of the Fœtus.—It is at times impossible to diagnose the death of the fœtus; but the following indications aid one in arriving at a conclusion :—

1. When death occurs *before labour has come on*, the mother experiences the sensation of weight in the region of the uterus. Rigors and chills are occasionally complained of. The movements of the child are not felt by the mother, nor are they to be made out by the accoucheur. The sounds of the fœtal heart, and the placental souffle, are inaudible. The abdominal walls become relaxed, and the umbilicus retracted. The breasts lose their plumpness and become pendulous. There is frequently sickness and foul breath, with a general sense of depression and severe illness. A fœtid discharge from the vagina is occasionally present.

2. *When labour has begun* the signs and symptoms are more easy of recognition. The absence of auscultatory sounds is still a foremost sign of fœtal death. The escape of foul liquor amnii, especially when meconium is present in it, is a pronounced indication. It is only, however, by an examination of the presenting part that it is possible to arrive at a positive diagnosis :—

a. When *the head* presents, the scalp, instead of being full and tense, is soft and thin. The "caput succedaneum"—*i.e.*, a tense œdematous swelling, commensurate with the size of the os, and dependent on delay in labour—is not to be felt in the head of a dead fœtus. The parietal bones grate on each other, and overlap considerably.

b. In *breech* presentations the sphincter ani does not contract on the finger being pushed into the rectum.

c. In *arm* presentations the limb will be cold, motionless, and shrunken.

d. In *funis* presentations the cord is found pulseless and abnormal to sight and touch.

Treatment.—When the child is known to be dead, induce labour as soon as possible. A fœtus, at the full time, may remain fourteen days in the uterus after it has ceased to live before the uterus attempts to expel it.

Mole Pregnancies.—A mole is the result of an arrest in the development of an embryo with hypertrophy of the membranes. This constitutes a "true" mole. A "false" mole is the name sometimes given to any solid substance which is expelled from the uterus other than the result of

impregnation, such as retained clots of blood, mucous casts of the uterus, flakes of condensed epithelial cells, and the like. A careful search, naked eye and microscopic, is required to find out whether a blighted ovum is present or not in the substances expelled.

Of the different kinds of moles the following are the more important:—

1. The *flesh* mole. When hæmorrhage occurs between the uterine wall and the placenta (placental apoplexy), or between the layers of the decidua (apoplectum ovum), the resulting coagulum of blood may, with the neighbouring membranes, undergo degenerative changes, resulting in the formation of a fleshy mole—mola carnosa. The chief seat of the disease is the decidua vera, in which the effused blood first coagulates, and finally becomes replaced by connective tissue. The embryo dies owing to the blood supply being cut off. The mole frequently grows in size after the death of the embryo, so that the abdomen rapidly enlarges, more so than in natural pregnancy. By-and-by, however, the swelling subsides, from the absorption of the fluid around the wasted embryo, thus betraying the state of things.

2. The *hydatiform* mole. This is not true hydatid disease, but merely a degenerative development of the villi of the chorion. The normal connective tissue buds, by which the villi develop, assumed an alteration in their nutrition, and are transformed into multitudes of vesicles. The whole growth has been, not very aptly, compared to a bunch of grapes. The death of the embryo is the result, and its expulsion is only a matter of time.

The *symptoms* of mole pregnancy are—

Peculiar maternal sensations, hæmorrhages, the uterus quickly attaining a large size, the absence of ballottement and all auscultatory sounds, followed by abortion.

The *treatment* is as for abortion.

Phlegmasia Dolens.—A disease frequently associated with the post-parturient state, but not altogether peculiar to it, as it is met with in non-parturient women and in men. It is determined by a coagulum in the veins leading towards either of the common iliac veins, most frequently the left. The coagulum does not extend to the inferior vena cava, but stops short at the spot where the iliac arteries cross the iliac veins, and this crossing is probably the cause of the stoppage. The iliac veins once blocked, the blood in the veins of the corresponding lower

limb will become coagulated. The lymphatics are, in all probability, attacked as well as the veins, and the blocking of both determines the peculiar condition of the limb. In the post-parturient state, the open uterine veins are the seats of the commencement of coagulation.

The *symptoms* come on usually within six weeks from the time of labour; they are characterized by slight rigors, headache, and febrile disturbance. Pain and tenderness extend along the lower part of the abdomen of the affected side, and down the groin, thigh, and calf of the leg. Frequently the pain follows the reverse order. The skin of the limb now becomes pale, tense and glossy; swelling, not œdematous, but hard, boardy or leathery, occasions the limb to become it may be twice or thrice its original size.

Prognosis.—The disease may end fatally by detachment of a part of the coagulum, which, getting free in the blood stream, may be washed through the right side of the heart and caught in the lungs, giving rise to sudden death from "pulmonary apoplexy," as it is called. The general tendency of the disease is towards complete recovery, although the limb may remain slightly enlarged.

Treatment. — Rest in bed, fomentations with hot turpentine stupes applied now and again. Bark and ammonia are freely administered by some, but cavilled at by others, whilst calomel, and calomel and opium find ready supporters.

ADDENDUM.

The Fœtal Circulation.—The aorta in the fœtus divides into iliacs at the lower part of the lumbar region, and from the internal divisions of these, two large trunks, the *hypogastric* arteries, are continued forwards in the allantois to the placenta. From the placenta the *umbilical vein* carries back pure blood to the fœtus. At the under surface of the liver the contents of this vein pass on through the *ductus venosus* to join the inferior vena cava.

The veins, from the head and neck and upper extremity, collect in the superior vena cava and pass through the right auricle down to the right ventricle; hence by the pulmonary artery, and (instead of going to the lungs) through the *ductus arteriosus* into the aorta. The ductus arteriosus contains venous blood and joins the aorta *beyond* where the vessels to the head and upper extremities are given off; hence the upper part of the fœtus receives pure blood, but the lower part—*i.e.*, the part below where the ductus arteriosus joins the aorta—receives mixed blood.

PART VI.

HYGIENE.

AIR.

We have already (p. 115) considered the composition and nature of the air. We have now to consider its influence upon human life. Nothing is more clearly proved by experience than that man will flourish under almost any circumstances of diet and climate, provided he lives freely in the open air; the scantiest diet, the sternest climate, under these circumstances, will only make him hardier and more vigorous. The success of what may be called the fresh-air treatment of disease of various kinds—of phthisis, of struma, of fevers, of blood-poisoning, &c.—show that pure air is no less beneficial to the diseased than to the healthy body. The atmosphere which surrounds the earth is naturally everywhere favourable to abundant and vigorous life. We will consider briefly some of the agencies at work to poison it, and the effects which these agencies produce.

I. Overcrowding.—Air which has once been breathed is robbed of about five per cent. of its oxygen, and gains instead about five per cent. or less of carbonic acid gas, a good deal of watery vapour, and small quantities of organic matter. The organic matter is what gives to crowded rooms, hospital wards, bedrooms, &c., which are not properly ventilated, their characteristic and unpleasant odour, and it is this matter which is dangerous to human life. Without the slightest exaggeration, we might tabulate the effects of breathing impure air thus:—

(*a*) *Minor Effects*:—Headache, nausea, dyspepsia, anæmia.

(*b*) *Graver Effects*, from constant inhalation of already breathed air:—Consumption, struma, mal-development. These effects are among the most common and most dangerous, because most insidious.

(*c*) *Gravest Effects*, from dense overcrowding:—Typhus fever (*see* Murchison "On Fevers" for evidence

of this), jail fever, and death, as in the well-known case of the Black Hole at Calcutta, where 146 men were crowded together into a small space, of whom 123 died within a few hours.

The means of guarding against these diseases are simple. Free ventilation of occupied rooms, the limitation of the number of individuals in rooms according to their capacity, and constant and regular exercise in the open air, are the measures necessary. It has been shown that when the carbonic acid gas in a room has been increased, by breathing, to 7 parts in 10,000, this is a sufficient indication that organic matter is present in a harmful quantity. It has also been proved by experiment, that to keep the air pure each adult requires at least 3,000 cubic feet of fresh air to be delivered to him per hour, and experience has shown that in confined spaces it is necessary to have at least 800 or 1,000 cubic feet of space for each person present. Given 1,000 cubic feet of space to each, then the air must be changed three times in an hour in order to supply the necessary amount of 3,000 cubic feet. If the space is only 500 cubic feet, the change of air must take place six times in an hour, and unendurable draughts are the result.

Tests for the Purity of Air in Rooms.—There are two simple tests that can be applied to any occupied room, besides many more complicated tests which we shall not consider.

The first is the test of the senses. If, on entering a bedroom or other room, it is obviously close, stuffy, or mal-odorous, ventilation is needed. In order to apply this test usefully, the person who uses it must have been for at least fifteen minutes previously in a pure atmosphere.

The second test has been proposed by Dr. Angus Smith. Take a wide-mouthed bottle, capable of holding $10\frac{1}{2}$ ounces of water; place in it half an ounce of lime-water; let it get filled with air in the room to be tested; close the mouth of the bottle, and agitate the lime-water freely by shaking. The bottle obviously contains a volume of air equal to 10 ounces of water; and if this volume of air contains more than 6 parts in 10,000 of CO_2, the lime-water will become milky.

II. Emanations from Diseased Persons are potent to make air impure. Where many persons with recent wounds are collected together—as in hospitals in time of war, erysipelas, pyæmia, and septicæmia are

of most frequent occurrence. Puerperal fever similarly makes its appearance in crowded lying-in institutions. All infectious diseases become increasingly virulent according to the concentration of those suffering from the infection. The means to be adopted in such cases include the free use of antiseptics, and, above all things, an almost unlimited supply of air from the outside.

Disinfectants, the word is here used in its general sense, may be classified as *gaseous*, *liquid and volatile*, *liquid but not volatile*, and solid.

(*a*) *Gaseous Disinfectants.*—First and most important is fresh air. For disinfecting newly vacated sick-rooms, sulphurous acid gas, chlorine, and nitrous acid gas, are those most commonly used. The room to be disinfected must be stripped bare of all woollen and similar materials, which should be disinfected in a way to be presently mentioned. Wall-papers should be removed and burned; all apertures by which air might enter must be closed by pasting brown paper over them. Sulphurous acid gas is best generated by burning sulphur (one pound to every 1,000 cubic feet of space) on a shovel over a tub of water, or in an earthen flower-pot. Chlorine gas may be generated by adding hydrochloric acid to manganese dioxide, and nitrous acid by adding nitric acid to copper. Any of these gases being freely generated, the room should be closed, and left to the influence of the disinfectant for twelve hours or more. The next steps are to freely expose the room to the external air, to scrub the floor and wood-work, to wash everything with dilute carbolic acid solution, to kindle a good fire in the grate, and, finally, whitewash the ceiling and re-paper the walls of the room.

(*b*) *Liquid and Volatile Disinfectants.*—Of these the most frequently used is a dilute solution of carbolic acid (one part of the acid to forty of water or more). This may be placed about sick-rooms; may be used for disinfecting plates, instruments, sponges, linen, &c. Solutions of sulphurous acid and chlorine gas are also useful, but both have powerful bleaching properties, and must not be used too strong.

(*c*) *Liquid Non-volatile Disinfectants.*—Permanganate of potash solution and Condy's fluid are perhaps the most widely used disinfectants. Their activity depends upon the ease with which the salt parts with its oxygen. These solutions are useful for washing instruments, for add-

ing to baths, &c. Any stains which they cause are easily got rid of by using a little dilute sulphurous acid.

(*d*) *Solid Disinfectants.*—Chloride of lime is much used for out-door purposes. Charcoal is useful on account of its great power of absorbing gases of all kinds, and many of the solid and liquid disinfectants in common use are more or less beneficial.

A mode of disinfection which can scarcely be included under any of these heads is the application of *dry heat*. This is peculiarly applicable to clothing of all kinds, and in all large towns there are kilns for applying heat on a large scale to such materials. Everything which requires to be so disinfected should be first placed in some soluble disinfectant, and should afterwards be baked for an hour or two.

III. Impurities in air, caused by decaying animal and vegetable matter. "Putrefaction is a concomitant not of death but of life," is an aphorism worth remembering. The disintegration of organic matter, by the ordinary mechanism of Nature, involves the production of countless millions of lowly organisms, many of which act deleteriously upon man. A stinking water-closet in a crowded house will produce a crop of sore throats, headaches, boils, abscesses, &c. Decaying vegetable matter will make a whole district malarious; and in these and other instances it seems likely that bacteria, which has been shown to play so important a part in many diseases, are the active agents; good drainage, free ventilation, and the rapid destruction, by heat or chemical agents, of the dead organic matter, are the chief methods of protection.

IV. Impurities in air from trades and manufactures. All trades which are conducted in crowded rooms are more or less injurious from the causes already mentioned, but special dangers are found when the trades are such as involve the setting free of fine particles of dust, of noxious gases, &c. Knife-grinding is notoriously fatal to the workmen engaged in it from the mechanical action, upon the lungs, of the fine particles of steel set free: miner's phthisis, mason's phthisis, and other germs of consumption, arise from like causes. Workers amongst phosphorus, mercury, lead, &c., are all subject to various diseases from inhaling minute quantities of these substances.

V. Absence of sunlight. As the chlorophyll of vegetable matter only acts upon CO_2, fixing the carbon in the form of starch ($C_6H_{10}O_5$) and liberating oxygen, in the

presence of sunlight, it is obvious that places which are shut out from light must suffer from the presence of excess of carbonic acid gas, if many living beings are huddled together. Besides this, the sunlight seems to act upon the blood in a manner somewhat analogous to its action upon vegetable matter, and all the processes of oxidation go on more actively in the animal body under its action. Valleys in which there is a little sunshine are unhealthy, and there seems some reason to believe, in spite of the good health of many Arctic voyagers during the dark winter months, that constant darkness has some effect in producing scurvy and other diseases of mal-nutrition.

VI. *Pollen grains*, by their abundance in the air at certain seasons of the year, often give rise to much irritation about the air-passages. Hay fever is caused by their presence, some individuals being much more subject to this form of irritation than others.

VII. Peculiar electrical conditions of the atmosphere, whose nature is at present little known, seem to have some effect in inducing epidemics of disease.

WATER.

The composition and sources of water have already been treated of; we shall here consider it, with reference to its influence upon health—

1. The uses and characters of good water.
2. The tests for suspicious water.
3. The diseases ascribed to bad water.
4. The precaution to be observed in using bad or suspicious water.

I. Uses and Characters of Good Water.—Water is a necessary article of food, and the animal body in all its parts is largely made up of it. It is the universal diluent, the carrier of food to every part of the body, and the cleaner and purifier of all the tissues. Good water should be colourless, tasteless or nearly so, and inodorous. It should yield little or no residue on evaporation, and should come from some well-known source free from contamination of any kind. The following Tables, copied from Dr. Wilson's "Handbook of Hygiene," are those given by the Rivers Pollution Commissioners, and show the nature of the various kinds of water most commonly used :—

TABLE I.

Wholesome	1. Spring water.	Very palatable.
	2. Deep well water.	
	3. Upland surface water.	Moderately palatable.
Suspicious	4. Stored rain water.	
	5. Surface water from cultivated land.	Palatable.
Dangerous	6. River water to which sewage gains access.	
	7. Shallow well water.	

TABLE II.—According to softness :—

1. Rain water.
2. Upland surface water.
3. Surface water from cultivated land.
4. Polluted river water.
5. Spring water.
6. Deep well water.
7. Shallow well water.

TABLE III.—Waters arranged according to the efficiency of their filtration in passing through various geological strata :—

1. Chalk.
2. Oolite.
3. Green sand.
4. Hastings sand.
5. New red and conglomerate sandstone.

II. TESTS FOR SUSPICIOUS WATERS.—It will be noticed that the waters which are suspicious are those which are likely to be contaminated with human or other excrement. A good general rule is to look rather to the source of a water than merely to chemical examination in deciding on its merits. Water may have to be tested for lead or other inorganic impurities.

Nessler's Test.—Nessler's solution is made with a solution of bichloride of mercury, iodide of potassium, and liquor potassæ. A few drops of this solution added to water containing ammonia gives a brown colour.

Permanganate of potash solution added to water containing organic matter in solution, loses its bright crimson colour.

Gold Test.—Boil 6 oz. of water with a few drops of solution of chloride of gold. If there is much organic matter a black or violet powder falls to the bottom.

Silver or Chloride Tests.—Add solution of nitrate of silver. A copious white precipitate indicates a suspicious water.

Tests for Hardness.—If water is hard from the presence of carbonate of lime the hardness is removed by boiling, and the consequent escape of CO_2 which holds the lime in solution (temporary hardness); if it is due to the presence of sulphate of lime or magnesia, it is not affected by boiling (permanent hardness). Clark's soap test is usually applied to determine the hardness of water. A standard solution of Castile soap in alcohol is added to the water. If lime, magnesia, baryta or alumina salts are present in any quantity they retard the formation of a lather, which if the water is soft is immediately formed.

Physical Examination.—Water to be tested should be examined as to colour, taste, smell, and presence of visible impurities. Some should be laid aside, and the lower strata should be examined with the microscope.

Tests for Lead.—Evaporate a gallon of the water to a small bulk; acidulate and pass through it a stream of sulphuretted hydrogen gas—a brown colour or a black precipitate indicates lead.

III. Diseases ascribed to Bad Water.—Among the diseases which have been most clearly traced, wholly or in part, to a contaminated water supply, are typhoid fever, cholera, dysentery, diarrhœa, lead poisoning, goître, stone in the bladder, &c. Typhoid fever, cholera, and dysentery are spread by the excrement of persons suffering from these diseases getting into drinking water. Diarrhœa may arise from the same cause, or from the water used containing excess of magnesium or other salts, or decaying animal or vegetable matter. Lead poisoning may occur from the contamination of water in passing through lead pipes or from being stored in lead cisterns: $\frac{1}{20}$th of a grain per gallon may cause serious symptoms. Goître seems to be caused mainly by drinking water which has passed through magnesian limestone.

IV. Precautions to be observed in using bad or suspicious water. Circumstances may arise in which only suspicious or bad water can be obtained. The methods of purification are—

1. Filtration.
2. Boiling.
3. Addition of certain substances.

Filtration may be carried on by passing the water through layers of sand, charcoal, &c. Convenient pocket-filters are made out of solid carbon.

Boiling water suspected to contain organic impurities is the most satisfactory means of purification. Intermittent boiling—that is, boiling the water for short periods, with intervals between—is more effectual in destroying germs than one long-continued boiling.

Various substances may be added to suspected water. Dr. Clark's process of making temporarily hard water soft consists in driving out lime by lime: lime-water is added to the hard water. The lime unites with the free carbonic acid gas to form carbonate of lime, and this, with the previously dissolved carbonate, is thrown down. Condy's fluid is sometimes added, and this acts by oxidizing organic matter. Alum is found useful in removing suspended organic or inorganic matters. It is a good rule never to use suspicious water unless in the form of tea or after boiling.

FOOD.

Food constituents may be classified into—

I. Organic.
- (*a*) Nitrogenous.
- (*b*) Non-nitrogenous. { *a*. Fats. / *β*. Amyloids.

II. Inorganic.
- (*a*) Water.
- (*b*) Salts.

The quantities of each of these required by a healthy man doing a fair day's work are as follow:—

Proteids	1,500 grains.
Fat	1,500 "
Amyloids	6,500 "
Salts	400 "
Water	40,000 "
Total	49,900 "

Of these foods the absolutely essential constituents are water and proteids. Without any of these death will result from starvation, even if abundance of the other constituents are present. Health may suffer by—

1. Bad food.
2. Improper food.
3. Insufficient food.

I. Bad Food.—*Adulteration* may be carried on with many articles of diet to a harmful extent. Milk is fre-

quently adulterated with water, wheaten flour with inferior products from other cereals, tea with leaves from other plants, and so on.

As milk is an article of diet of the first importance in the sick-room and for children, we will here consider the tests of good *unskimmed* milk.

It should be of a full white colour, free from sediment or flocculi. Its specific gravity should be from 1024 to 1032, and when left to stand it ought to yield about one-tenth of its volume of cream. Skimmed milk has a somewhat higher specific gravity than pure milk, so that the specific gravity test alone is not sufficient.

The various starches which may be used to adulterate flour can be detected by the shapes of their corpuscles as seen under the microscope.

Food which has undergone putrefaction, and flesh from diseased animals, are often exposed for sale. The use of the microscope in many of these cases will reveal the presence of parasites or bacterial organisms. *Trichina spiralis*, found in pork, the *echinococcus* and other parasites, produce serious diseases in man. The flesh of animals dying from disease of non-parasitic origin, although it can often be eaten with impunity, should be condemned as unwholesome. If it is absolutely necessary to use any suspicious meats, they should be well cooked before being taken as food.

II. Improper Food.—People of all ages, but especially children, suffer much from bad dietaries. Bad milk, irregular meals, and the administration of meat, &c., to infants, are prominent causes of disease; rickets, diarrhœa, and vomiting arise from such causes. Among adults, irregular meals, excessive use of alcohol and other stimulants, excessive meat diet, &c., are responsible for the majority of the minor ailments of life. In constructing dietaries for men and women, the nature of their occupation must be carefully considered. Great physical exertion demands a generous proteid diet. If there is much exposure to cold, fats are required. The condition of the teeth, also, must often be taken into consideration. If the power of mastication is imperfect, the diet should consist of articles which need little preparation at the mouth. The absence from the diet of vegetable salts for any lengthened period, produces scurvy and purpura.

III. Insufficient Diet.—If the food, although good in quality, is deficient in quantity, the general health rapidly

becomes deteriorated. Diarrhœa, emaciation, feebleness, and a proneness to attacks of acute diseases, are prominent symptoms of slow starvation. (*See* Famine Fever.)

DWELLINGS.

Of the more glaring defects in dwelling-houses it is not necessary to say much. Overcrowding, bad ventilation, limited and impure water supply, are all obvious causes of disease which exist to a greater or less extent everywhere. We will here consider some of the principal points which ought to be looked to in examining the sanitary condition of houses. Doubtless the time will come when no one will think of taking a house without a good character from some competent authority, any more than they would think of taking a confidential servant without satisfactory references.

Bedrooms.—These ought to be large enough to allow at least 1,000 cubic feet of space for each adult using them. The windows should open above and below. There should be a fireplace in each, with the chimney in good order. The rooms when occupied should be plainly furnished, with as little woollen or cloth material as possible, especially if used as sick-rooms. Care should be taken that no drain-pipes open in or near these rooms. During sickness, and when occupied by aged and infirm persons, bedrooms should be kept at as nearly uniform a temperature as possible; from 60° to 65° F. is a good standard. The rooms should be frequently and well aired, and kept dry.

Sitting Rooms.—These should be chosen with as large an amount of cubic space as possible. They should be light, airy, not overheated, or cold.

Kitchens.—Underground kitchens should, where possible, be avoided. The drainage and water supply should especially be looked to.

Water-closets, Lavatories, and Drains are the chief sources of danger in otherwise well-built houses. Where it is possible, the water-closets should be built altogether out from the house. The same cistern should never be used for the closet and the water supply of the house. The cistern for the supply of water for domestic use should be carefully covered in, and a constant supply is preferable to an intermittent one. Lavatory waste-pipes frequently communicate directly with the closet waste-pipes, and in this way there is a ready access of sewer

gas into the house. Bad smells in a house should always be looked on with suspicion, and if the odour of some strongly smelling substance, such as carbolic acid or ether, on being poured into the drain outside the house can be detected indoors, it is evident that sewer gas can travel in the same way. Frequent flushing of closets and drains, and efficient ventilation, are the best modes of protection against such accidents.

Water Supply.—This has been already considered. The close approximation of cesspools to wells should always be looked on with suspicion. The amount of the water supply ought to be about 25 gallons daily for each person to each house. This quantity is assigned for the following purposes, thus :—

Domestic purposes	12 gallons.	
Baths	4	,,
Closets	6	,,
Waste	3	,,

Exercise and Cleanliness.—Without some amount of daily exercise in the open air, the health of men and women is sure to suffer. It will frequently be found that in the case of young persons with a tendency to phthisis, the disease will be avoided by apparently courting danger, by exposure to cold, and all the vicissitudes of the weather; while, on the other hand, when every care as it is supposed is taken to avoid draughts and cold, the disease rapidly comes on. It matters little what form of exercise is taken, so long as it is taken regularly and not to excess—walking, riding, swimming, running, are all equally helpful in keeping up the standard of physical health, and warding off the attacks of disease.

The Daily Bath is of great use in a variety of ways. It keeps the skin in good order, and makes it to fulfil well its natural functions as an excretory organ, or heat regulator, &c. The bath also promotes tissue changes, and so improves digestion, assimilation, and circulation. Very young and delicate persons may not be able to stand the cold bath; in such cases, warm water may be added until experience shows that the bath can be taken with comfort. In the case of robust and healthy individuals, an open-air bath is generally to be preferred when circumstances permit. Daily sponging of the whole body is of the greatest use in all cases of febrile or exhausting disease, and is one of the best ways of avoiding bed-sores and promoting sleep.

HEREDITARY TENDENCIES TO DISEASE.

Many diseases have a strong tendency to appear in successive generations. Phthisis, nervous diseases, cancer, Bright's disease, gout, rheumatism, and even such diseases as typhoid fever and scarlet fever, are often found to attack the members of certain families with great malignancy. In many of these cases careful living will avert the threatened attack, or the disease will skip a generation or two altogether. Intermarriage between near relations nearly always intensifies any peculiarities which exist in a family. Thus, if two cousins belonging to a consumptive race marry, their offspring, if any, are almost sure to be phthisical. In the case of mental diseases the tendency is even stronger towards the reproduction in offspring of insanity, idiocy, and epilepsy. In all such cases the only way to avoid such results is to avoid marriage. The chances of having diseased children are lessened by marriage with healthy persons, but by no means eliminated. Tendencies to disease which appear late in life in parents, often appear late in life in their children, and often under such different circumstances that nothing apparently can be done to ward off the disease.

General Conclusions.—The greater number of diseases is caused by improper conditions and habits of life. It is useless to look for a permanent cure in these cases from drugs or other treatment if the permanent causes of the diseases are unattacked. Mrs. Partington with her mop might as well hope to keep back the Atlantic, as the physician to be successful in treating phthisis, fevers, dyspepsia, &c., caused and kept up by foul air, dirt, bad food, and intemperance. In diagnosing and treating disease, the conditions under which the patient lives and has lived, and his hereditary tendencies, are of the first importance. Finally, man is an animal formed for living much in the open air, and he will thrive best physically under circumstances which allow him sufficient exercise, abundance of fresh air, a clean skin, and a fair supply of plain unstimulating food.

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